This manual applies to the 26-303 Moisture Monitor, Lot 4.

NOTE

If instrument has been modified and bears a Type Number 26-303MA, 26-303MB, etc. see Table of Contents for appropriate section of Part 8 for description of modification.

CAUTION

The 26-303 Moisture Monitor is not explosion proof. Although each instrument has been thoroughly tested for leak-tightness at the factory, it is entirely possible for the various tube fittings to develop leaks due to vibration, repeated connecting and disconnecting, etc. It is strongly recommended that suitable safety precautions be taken when the instrument is used to sample streams containing flamable vapors. The precautions include: 1) careful leak-check of the instrument periodically, 2) operating with the instrument cover off (instrument should be protected from drafts), or 3) air-purging the case by attaching a fitting at the rear and providing several vent holes.

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PART 1

GENERAL DESCRIPTION

1.1 GLOSSARY OF ABBREVIATIONS AND SPECIAL TERMS USED

PPM	Parts per million, expressed in terms of parts of water per million parts of sample by volume.
Electrolysis Cell	Cell containing two electrodes and phosphorous pentoxide desiccant to absorb and electrolyze water vapor from a passing sample stream.
Saturated Cell	A condition in an electrolytic cell when the phosphorous pentoxide coating has absorbed more water than can be instantaneously electrolyzed, requiring drying of the cell.
Flooded Cell	A condition of extreme saturation which dissolves the phosphorous pentoxide coating in a cell, so that recoating is necessary.
Water Hang-Up	Water which is trapped or absorbed into the walls or fittings of a system.
Tramp Water	Water which has entered a sample stream from the walls or fittings of a system.
System Equilibrium	Condition within the system when water is absorbed into the walls of the system at the same rate as it is given off.
Entrained Dirt Particles	Dirt carried by a sample stream.
Dew Point	That temperature at which a mixture of a gas and water vapor is saturated with water vapor.

1.2 PRINCIPLE OF OPERATION

ANALYSIS BY ELECTROLYSIS: The analysis is accomplished by continuously and quantitatively absorbing and electrolyzing all water present in a sample stream entering the instrument. The electrolysis current, which is related directly by Faraday's Law to the mass-rate-of-flow of water into the instrument, is used to accurately indicate the sample's water content. Because changes in sample-flow rate, as well as changes in concentration, affect the mass-rate-of-flow of water into the analyzer, the flow is kept constant by using a flow controller. The indicated current is thus proportional only to the water concentration, expressed conveniently in parts per million by volume.

1.3 GENERAL DESCRIPTION OF UNIT

This precision instrument is designed specifically to detect and measure from 1 to 1,000 parts of water per million parts of sample gas. It is continuous-reading and will accurately measure either moisture content or dew point in gases and gaseous mixtures.

The heart of the instrument is the electrolytic cell, which has the unique property of responding to water but to practically no other substance. (For a more complete description of the electrolytic cell, see Appendix A.)

Since the electrolytic cell consumes a given amount of current for a given amount of water, the ppm water in a sample stream flowing at a known rate through the instrument correspond to a known current. Referring to Fig. 1:01, it may be seen that sample flows into the cell from the inlet fitting, then through the flow controller and exits through the outlet fitting.

Electrically, the cell is connected in series with a meter, which can be attenuated, and with a constant voltage d-c power supply. Since the sample flow rate is controlled to a predetermined value, the meter and attenuator can be calibrated so that the readout corresponds exactly and linearly to ppm water in the sample stream. Virtually no current flows in the cell when the sample stream is completely dry, so the instrument readout is essentially linear from 0 ppm up to its maximum rated capability.

1.4 SPECIFICATIONS

Power Input: 105 to 125 v a-c, 50/60 cps nominal 10 watts
or: internal 67.5 v battery

Weight: Nominal 15 lbs

Sample Pressure: 20-100 psig

Sample Flow: 100 cc/min, adjustable

Sensitivity: 10 ppm full scale on X1 range

Accuracy: 5% of full scale on any attenuator range for sample flow of 100 cc/min

Dynamic Range: 1-1,000 ppm for sample flow of 100 cc/min

Noise: Less than 0.2 ppm on X1 range excluding transients

Response Time: 30-sec or less for a 63% response to a large step change, not exceeding 1,000 ppm, in either direction

Sample Temperature: Not to exceed 50°C at instrument inlet, and not less than 10°C

Temperature Stability: Temperature variations will change the sample flow rate, causing an error in reading not to exceed 0.3% per °C

1.5 CONDITIONS AND SERVICES

1.5.1 Warranty

The current warranty conditions are stated, along with other conditions of sale, on the reverse side of the CEC quotation form.

Most shipments are f. o. b. our plants, so that delivery and the beginning of the warranty period is the shipping date.

Items such as tubes, batteries, lamps, diodes, transistors, cells, and filaments, because of their expendable nature, are not warranted by CEC.

Purchased assemblies, such as amplifiers or readout equipment will bear the manufacturers' standard warranty and the original warranty period will not be extended by CEC.

Valid warranty claims will be corrected by no-charge repair or replacement of the defective part at CEC's plant, transportation both ways to be prepaid by the customer. If desired, the no-charge replacement part may be installed at the customer's address by a CEC Service Engineer at our standard service rates.

1.5.2 Shipping Damage

Damage incurred in transportation is the carrier's liability. Most CEC shipments are f.o.b. our plants, with title transfer to the customer at our shipping dock. It thus becomes the customer's responsibility to report shipping damages to the transportation company and file claims for transit damages.

1.5.3 Parts and Repairs

Parts manufactured by CEC or those difficult to obtain through local electronic dealers are listed by CEC number in this manual.

Manual schematics are in sufficient detail to permit identification of standard high quality electronic components, permitting the local purchase of most tubes and parts.

To insure prompt and accurate processing of your order, we ask that the following information always be included:

Serial number of the instrument for which parts are being supplied
CEC part number
Description of the part
Chassis or assembly number, where applicable
Schematic symbol or designation
Method of shipment desired
Your purchase order number

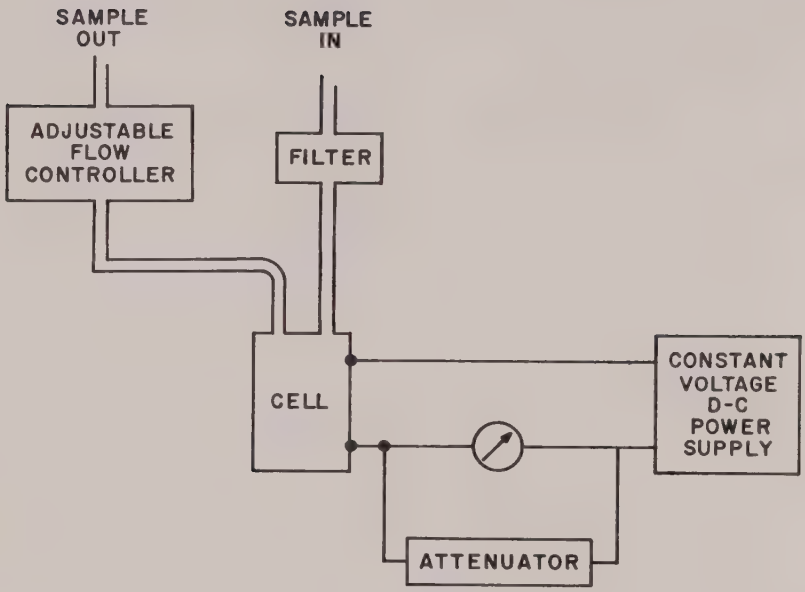
Equipment or parts to be repaired should be addressed to A&C Repair Department, Consolidated Electrodynamics. It is helpful to our Repair Dept. to note the reason the part is being returned for repair, with a brief description of the failure or malfunction.

If a quotation for repair charges is requested before repair work is initiated, this should be clearly stated on the shipping invoice.

To reduce downtime during repairs, CEC has an exchange policy on some items such as electrolytic cells. In using this plan, the customer issues

a purchase order for the full price of the new cell, requesting exchange credit. Full credit, less cost of repair, will be issued upon receipt at our plant of the repairable cell.

Parts prices and exchange prices may be obtained from your nearest CEC field office.



26-303 BLOCK DIAGRAM

FIG. 1:01

PART 2

SAMPLING TECHNIQUES

As in the case of many other analytical instruments, sampling techniques are of the utmost importance in the use of this instrument. Failure to observe necessary precautions in sampling can result in poor response, incorrect readings, or both. The most common causes of difficulty in this regard arise from the connecting lines and fittings or from the nature of the material being sampled.

2.1 INLET TUBING AND FITTINGS

In setting up the sample inlet system four points should be observed:

2.1.1 Locate the sample takeoff point for the system to be investigated at a place where the sample gas obtained will be representative.

2.1.2 Keep all lines between the sampling point and the instrument as short as possible.

2.1.3 Minimize the surface area of the sample tubing and fittings that are exposed to the sample.

2.1.4 Use no material in the inlet system which has been exposed previously to high moisture or which can absorb and desorb large quantities of moisture.

The sampling components (tubing, valves, etc.) should be made from material having low moisture absorption characteristics. Stainless steel is preferred, but copper and brass are acceptable. Most plastics or elastomeric materials are not satisfactory because of their relatively high moisture permeability. However, Teflon polytetrafluorethylene resin components can be used, provided the wall thickness is great enough to eliminate the possibility of leaks due to pinholes. All tubing should be 1/4 inch O.D. or smaller, and pipe fittings should be no larger than 1/4 inch. Valves should be equivalent to the smaller Hoke needle valves. Pipe "dope", rubber, and similar materials should be avoided at all cost. Where leaks are encountered, American Sealants Co. "Locktite," Grade A, may be used without fear of deleterious effects.

When the moisture monitor is to be used for continuous sampling of a single stream, it should be mounted as close as possible to the sampling point. Since the sample flow rate through the instrument is 100 cc/min, it is possible

to calculate the approximate response time by dividing the estimated sample system volume by this figure. If the calculated response time is too great, or if it is expected that the moisture level of the process will vary widely, a by-pass system should be constructed (see Part 7.1). Adjustment of the flow-rate through the sampling system then may be made as high as necessary to produce the desired response time. Using this technique, most of the flow is by-passed around the instrument while 100 cc/min is analyzed

Such a by-pass system may also be valuable when the instrument is in portable service analyzing discrete samples. Its purpose in these applications is to assist in purge-drying gas-cylinder valves, pressure regulators, and tubing, prior to making a moisture determination.

Where rapid response is required, or where particularly small concentrations are to be measured, equilibration time may be reduced by heating the sample-inlet system. In assembling this system, care should be taken to ensure that there are no leaks. The system should be leak-checked periodically, particularly if it is in portable service.

2.2 INTERFERING AND CONTAMINATING SUBSTANCES

In this discussion a distinction will be made between interfering and contaminating substances on the following basis: interfering substances will be regarded as causing an incorrect instrument reading, whether or not the instrument is injured; contaminating substances as those which cause injury to the instrument whether or not the value of the reading is affected. There are thus four separate categories into which a substance may fall.

2.2.1 Substances which do not interfere or contaminate

These substances are typified by the inert gases, nitrogen, air, and oxygen (except as noted below), natural gases, and many aliphatic and aromatic hydrocarbons.

2.2.2 Substances which only contaminate

Corrosive acid gases will corrode the instrument tubing and flow control system, but will not harm the cell, barring a few exceptions noted below. Typical examples are chlorine and sulfur dioxide. They can be handled by an instrument with a modified, corrosion-resistant flow system.

Some hydrocarbons cause no interference, but gradually coat the cell with a polymeric coating; ethylene, propylene, and butadiene are examples. This coating will render the cell inactive, often in a relatively short period of time. Special approaches can sometimes be designed to minimize this problem.

Entrained liquids and solids can also cause contamination without interference, resulting in cell failure or in sample system failure. Proper filtering is usually a satisfactory solution, and CEC is prepared to provide information and equipment for this purpose (see Part 7.4).

While permanent damage may result to the flow systems of unmodified instruments in some of the above examples, permanent damage to the cell rarely occurs.

2.2.3 Substances which only interfere

Nitric oxide, and some freons cause the instrument to read incorrectly. While the mechanisms of these interferences are not well understood, special techniques can sometimes eliminate them.

Hydrogen and, under severe conditions, oxygen or air, may cause the moisture monitor to read incorrectly. A special technique is available to cope with such problems, and is outlined in Appendix B.

2.2.4 Substances which both contaminate and interfere

Entrained liquids and solids often have both of the above effects, and certain materials, such as graphite dust, usually cause irreparable damage. Precautionary measures should always be resorted to in doubtful cases.

Hydrogen sulfide and hydrogen fluoride cause permanent damage in most cases, and should not be run under any conditions. Traces of hydrogen sulfide (one ppm and less) can sometimes be tolerated, though eventual poisoning of the cell occurs. Hydrogen fluoride will inevitably destroy the cell and usually the sample system.

Ammonia and other basic materials react with the acidic cell coating, rendering the cell unresponsive in a short time. Liquid samples cannot be passed through the cell as liquids, because the cell coating will be washed away. Liquid analysis techniques are discussed in Part 3.1.7.

2.3 SAMPLE STREAM REQUIREMENTS

In addition to the sample stream requirements previously noted, it is most important that the following conditions should be met.

2.3.1 All particulate matter larger than 10 microns must be filtered out

2.3.2 Maximum allowable sample temperature is 50°C

2.3.3 Sample must be free of oil mist and liquids

PART 3

OPERATING INSTRUCTIONS

3.1 PARAMETERS AFFECTING OPERATION

The following information should be carefully studied to insure most accurate and comprehensive utilization of the 26-303 Moisture Monitor.

3.1.1 Calibration and Flow Rate

Normally the 26-303 does not require calibration since electrolysis for measuring is specific to water. Response of the analyzer is linear to less than one part per million with a wide variety of samples which include halogenated or fluorinated hydrocarbons. It may be necessary, however, to readjust the sample flow rate through the analyzer if samples of different densities are run. The flow rate is set at the factory for 100 cc/min of dry helium at atmospheric pressure and 25°C. For greatest accuracy in measuring samples of different densities, the flow rate should be readjusted to 100 cc/min (at the sample temperature and pressure) for the sample being tested (see Part 5.1).

3.1.2 Accuracy

The accuracy of the moisture monitor is within ±5% of full scale of the indicated reading, provided sample flow rate is properly adjusted. The instrument indicates not only the water in the stream being sampled, but also any "tramp" water that is picked up from pipes, valves, and fittings of the sampling system. With streams of low moisture content, "tramp" water may represent an appreciable portion of the instrument reading. Care must be exercised to minimize its effect by insuring that the sample system components are as dry as, or drier than, the sample gas. See section 2.1 for detailed discussion of sample system design techniques.

3.1.3 Voltage

Line-voltage variations up to ±10% will not affect the operation of the moisture monitor, since the self-contained power supply is d-c regulated. The nominal no-load voltage at the cell is 75 volts d-c on a-c operation and 67 volts d-c on battery operation. The exact value is not critical, but should not fluctuate, as fluctuations will show up as transients in the reading. The battery should be replaced when it falls to 45 volts with a load of 10 ma.

3.1.4 Temperature

Sample temperature affects the gas density and, therefore, the total mass of water entering the cell. Although the instrument continues to indicate correctly the mass-flow-rate of water, the change in gas density affects the conversion to concentration by a small amount. For a fixed volumetric flow of 100 cc/min at atmospheric pressure, one part-per-million of water produces exactly 13.2 microamperes of current in the cell at room temperature of 298° Kelvin. At other temperatures the current is 13.2 microamperes times the ratio of 298°K to the absolute temperature in °K. The correction to be applied to an instrument calibrated at room temperature is thus about 0.3%/°C. Instrument readings must be corrected upward by this amount for temperature rise, and downward for temperature drop. If wide deviations in temperature are encountered, the sample flow through the instrument can easily be changed to match the new conditions by adjusting the needle valve (see directions in Part 5.1 for flow-rate adjustment).

A rise in temperature any place upstream from the cell may cause a transient response resulting from "tramp" water driven out from the walls of the sample system. A sudden temperature increase in excess of 5°C might easily cause a transient peak equivalent to a large percentage of the indicated reading. Lowering the system's temperature may produce a similar transient downward. Instruments which are used indoors should be sheltered from drafts; those installed out-of-doors should be housed in insulated enclosures.

3.1.5 Sample Pressure

The input pressure of the sample does not affect the moisture monitor's response since the flow controller maintains a constant mass-flow-rate of sample through the instrument. Normally regulated for a pressure range from 20 to 100 psig, the 26-303 may be made to accommodate higher pressures by means of an external regulator to reduce the sample pressure to an appropriate value. Also atmospheric pressure may be sampled by use of a downstream constant vacuum source. Contact CEC for further information.

3.1.6 Speed of Response

For a stepwise change upward in moisture level the instrument will reach 63% of its final reading within 30 seconds. The response may be somewhat longer--45 to 60 seconds--for a stepwise change downward. In actual practice, however, stepwise changes are improbable. The response time of the moisture monitor plus its associated sampling system also depends on

whether the instrument is used on a continuous or a discrete sample. The reason for this difference lies in the time required for the instrument and sampling systems to become equilibrated to the moisture level of the sample. When sampling a stream having a given moisture content, the sampling system and the moisture monitor reach a state of equilibrium with the moisture level of the sample. If the moisture level of the process changes, a finite time will be required for this change to appear at the sample point and similarly for the change to appear at the instrument. The time to equilibrate to the new moisture level is a function of the process flow rate, the effective surface area of the process piping, and the process temperature, as well as the same parameters for the sampling system. So long as the sample flow rate, effective surface area of the sampling system, and the sample temperature, are comparable to the corresponding process parameters, the moisture monitor can be expected to follow the moisture level of the process. The response time of the instrument is then essentially that of the process itself. Obviously, the system used to connect the moisture monitor to the sample source should be kept as simple as possible to reduce the surface area capable of harboring "tramp" water.

When analyzing a discrete sample, for example checking the moisture level of a cylinder of gas, the response time is the interval required for equilibrium to be established between the moisture in the sample and in those components with which the sample comes in contact. If the sample tubing has been exposed to atmosphere, or is made of material of relatively high-moisture-absorbing capacity, the response time will be relatively long. With careful operation, an accurate answer can be obtained in about 15 minutes.

3.1.7 Analysis of Liquids

Liquids cannot usually be analyzed directly by the 26-303 Moisture Monitor, since the process would wash away the coating inside the electrolytic cell. However, by utilizing evaporative techniques, a considerable number of liquid samples can be analyzed.

For liquids which boil at temperatures below 50°C, an accessory Sample Vaporizer Regulator, Cat. No. 38-001A, is available to vaporize the liquid sample. Analysis of samples vaporized in this manner is identical with conventional sample analysis except that the moisture monitor and sample inlet systems must be maintained at a constant temperature above the liquid boiling point to prevent condensation within the instrument. This is most readily accomplished by housing the 26-303 in an insulated, heated, and thermostatted cabinet.

For liquids which boil above 50°C, or where it is not desired to use a vaporized sample, it is often possible to use a stripping technique. An instrument operating on this principle and designed for use as a continuous process monitor has been developed by CEC. It has already been used to measure the moisture content of a variety of liquids, including aliphatic and aromatic hydrocarbons, their halogenated derivatives, and many commercial industrial solvents.

3.1.8 Considerations for Low-Level Analysis

When analyzing samples of very low moisture content, the most important factor contributing to accuracy is the attaining of equilibrium between the moisture in the sample and the moisture in the system which it contacts. Process lines, cylinder valves, sampling tubes, and intermediate sampling containers are all susceptible to adsorption and desorption of water. In practice four considerations greatly assist in minimizing "tramp" water: 1) elimination of moisture-absorbing materials from the system; 2) reduction of the system's interior surface to a practical minimum by use of 1/4-inch or smaller tubing, and use of by-pass flow; 3) system insulation to prevent large swings in temperature; and 4) pressure control within the system to prevent extreme pressure fluctuations.

An example which readily serves to illustrate problems caused by "tramp" water is apparent when the water present in a cylinder of dry nitrogen is being measured. Varying conditions will cause the actual water content of the gas to fluctuate greatly. If the sample is drawn off rapidly, there is a marked reduction in water content; if the flow is reduced, the water content returns to a higher value. The temperature of the cylinder also affects the water content. A 10°F increase in temperature, for example, may double the water content. In addition, an increase in water content occurs when the cylinder is nearly empty. These effects point to the desorption of water from the cylinder walls, valves, and piping, a condition which apparently does not improve with time.

In testing a cylinder gas for moisture content it is essential that conditions of sample flow rate, temperature, and cylinder pressure should closely approximate the conditions under which the cylinder is to be used. It is also apparent that a cylinder of gas cannot serve as any more than a very rough analysis standard at these low concentrations. The desorption effects described are very much worse when the components have been recently exposed to atmospheric moisture; therefore, a very large sample should be taken in order to actually equilibrate the system.

3.2 DETAILED OPERATING INSTRUCTIONS

3.2.1 Preliminary

When an instrument is newly unpacked, or is being returned to service after a period of disuse, it is advisable to put the instrument on a dry gas stream for a short time prior to connecting it to the sample lines. Connection should be made through a short length of 1/8-inch tubing. Copper tubing is satisfactory although stainless steel or Teflon are better.

The translucent plastic protecting cap slipped over the end of the electrolytic cell should be removed by pulling straight out. This cap is intended to exclude dirt and moisture and should be replaced on the cell whenever it is out of the instrument. Install the electrolytic cell in the instrument by sliding it straight into the cell holder in such a manner as to engage the cell ports with the nozzles in the cell holder. Two orientations are possible and are equivalent - no polarity need be observed. Screw the cell cap on until it stops; do not force it beyond this point.

Oil-pumped dry nitrogen is recommended as the gas source, but air, argon, helium, etc., may be used if free of entrained dirt and liquid and with a dew point of -70°F or lower.

The instrument should be plugged into a 115-volt, 50/60 cps a-c line (not d-c) and the attenuator switch placed in the X100 position. Make sure the slide switch in the rear is in the "AC" position. Adjust the gas pressure into the instrument to 20-40 psig and check to see that gas actually flows through the instrument. If the meter reads off-scale for more than a minute or so, turn the attenuator to the CELL position. (Note - the meter is protected against overloads in all attenuator positions.) The meter now reads the voltage at the cell (from 0 to 20 volts) and, if this voltage is above 2 volts and is rising, or is above 20 volts, the cell is drying down. In the event the voltage is less than 2 volts and/or is not rising, consult Part 6 for possible causes.

If normal dry-down is indicated, return the attenuator to the X100 position. Depending on the length of sample tubing used, prior tubing service, and the moisture content of the sample gas, a steady reading should be reached in 5-30 minutes after the meter moves on-scale. Transient noise should not exceed 2% of full scale under these conditions, if it is present at all. See Part 6 for recommendations if noise is excessive or persists.

Following the directions in Part 5.1, the flow rate through the instrument should be measured and adjusted to 100 cc/min by means of the the valve on the flow controller inside the instrument. This adjustment will be valid when changing from one stream to another only if the gases are the same. For this reason, readjustment may be necessary when the instrument is later connected to the actual sample.

Assuming that no difficulty is experienced in this preliminary test, the instrument is ready for use. Turn off the sample gas to it and disconnect the sample line. Do not turn off the power to the instrument until it is necessary to do so in order to move it, and always turn off the gas supply before turning off the power. The electrolytic cell will continue to absorb moisture from flowing gas even though it does not electrolyze it, and will consequently become saturated. Leaving the power on, even in the absence of gas flow, helps keep the cell dry.

If difficulty arises in performing the above operations, turn to Part 6, Troubleshooting.

3.2.2 Battery Operation

A 67.5-volt battery (Burgess XX45 or equivalent) may be installed in the instrument if desired. The instrument cover must be removed to gain access to the battery holder, which is connected to the instrument by means of the connector already wired in.

Battery operation is selected by placing the slide switch on the back panel in the proper position. The OFF position of the attenuator disconnects the battery. Battery replacement is recommended when the battery voltage, measured at the battery terminals, drops to 45 volts under a load of 10 ma. This current corresponds to a moisture level of about 750 ppm.

3.2.3 Analysis of a Continuous Sample

The conditions of service discussed herein pertain to fixed operation on a continuously flowing sample. Sampling procedures outlined in Part 2 should be followed. Once the instrument is placed in service, little or no maintenance is required under normal conditions.

When the instrument has been attached to the sampling system, and before sample is permitted to flow through it, the electrical power should be turned on. Power may be supplied from 115-volt, 50/60 cps mains or from

the internal 67.5-volt battery. A slide switch on the back of the instrument selects either a-c power or battery power.

Sample may now be admitted, with an input pressure of 20-100 psig. Subsequent adjustments and tests may be made in accordance with the instructions in Part 3.2.1, starting with the second paragraph. Sample flow may be adjusted as necessary, as described in Part 5.2.

The effluent gas from the moisture monitor is normally vented to air at the outlet fitting, but with the attachment of a suitable length of tubing, may be dumped into a hood or exhaust stack if desired. It is not normally permissible to dump the effluent into a line at a pressure different than atmospheric, since the flow calibration depends on the pressure at the outlet fitting. Special techniques for measuring flow at pressures other than atmospheric are discussed in Appendix G.

In certain cases, a by-pass flow meter, described in Part 7.1, may be advantageously employed to shorten the response time of the moisture monitor.

3.2.4 Analysis of Discrete Samples

It is often desirable to check bottled gases, small amounts of special samples, or to intermittently monitor certain process streams. Since the moisture monitor is lightweight and equipped for battery operation, it is ideally suited for such tasks. In these cases, sampling techniques are of paramount importance. Particular attention should be given to keeping lines short and to purging them sufficiently before use in order that equilibrium will occur in a short time. A by-pass flow meter (Part 7.1) is a great aid in obtaining both accuracy and speed of analysis.

When the instrument is being transported from place to place for sampling, it should have a battery installed and the power should be left on. This will not discharge the battery rapidly if the meter reading is low, since the current drain at 60 ppm is less than 1 ma. The gas inlet and outlet fitting should be capped off to prevent moisture and dirt from entering the lines during transportation.

At the sampling site either a-c or battery operation may be employed; response time and accuracy will be the same. It is impossible to predict just how long it will take to reach a true instrument reading since samples and sampling conditions vary so widely. Fifteen to thirty minutes is a reasonable

figure for a sample like bottled nitrogen with a moisture level of 50 ppm. Proper purging and by-passing can result in a considerable saving of time.

3.2.5 Sampling Several Streams

One instrument may be used to sample several streams if the sampling points are close together. A solenoid valving arrangement, or a manual switching system, may be used, depending on individual requirements. CEC has designed many such systems for special applications, and inquiries are invited.

3.2.6 Attaching a Recorder

Two terminals are provided on the back of the instrument for attaching a high impedance recorder. Low impedance devices, such as meters or recorders using a meter type indicating movement, are generally not satisfactory. The recorder used should have an input impedance exceeding 10,000 ohms.

The output of the instrument is adjustable from 0 to 100 mv for a full scale meter reading, by means of the screwdriver-adjust potentiometer adjacent to the recorder terminals. The output impedance is 10,000 ohms or less, and is suitable for most types of millivolt recorders.

3.3 STANDBY OPERATION

In order to permit rapid equilibrium when sampling on an intermittent basis, it is advisable to leave the power on and to permit a slow (5-10 cc/min) flow of dry nitrogen or similar gas through the instrument when it is on standby. Battery power may be used if desired, since the current drain when the instrument is dry will be negligible -- only 13.2 microamperes per ppm indicated meter reading.

Flowing a dry gas through the instrument has this advantage, that the sample system, as well as the cell, stays dry. If this arrangement is not possible, the inlet and outlet fittings may be tightly capped off.

If the instrument is to be turned off for an extended period it is advisable to remove the electrolytic cell from its holder and replace the protective cap with which it was shipped.

PART 4

FUNCTION OF COMPONENTS

4.1 ELECTRICAL SYSTEM - Schematic C-135350

4.1.1 Cell Power Supply

T-101, which is protected from overload current by F-101, supplies 250 v a-c to the full wave rectifier, V-102. The +145 v d-c output of the rectifier is filtered by the combination of R-101, R-102, and C-101, and then further regulated to +75 v d-c by the constant voltage glow tube V-101.

S-102, in its AC position, impresses the regulated 75 v d-c on the cell. In the DC position, the internal 67.5-v battery, BT-101, is switched across the cell, allowing the instrument to be disconnected from the a-c power line.

4.1.2 Output Attenuator

The cell and output circuit are connected in series between the plus terminal of the cell power supply and circuit ground.

Attenuation of the cell current is accomplished with S-101B and the associated resistors R-104 through R-108 which act as shunts across M-101. Functions of S-101 are shown in the chart below:

Position S-101	Function	F. S. Meter Sensitivity
Off	Disconnect power, short circuit cell	--
Cell	Measures cell voltage	20 volts
X100	Atten. cell current	1,000 ppm
X30	Atten. cell current	300 ppm
X10	Atten. cell current	100 ppm
X3	Atten. cell current	30 ppm
X1	Reads cell current direct	10 ppm

4.1.3 Output Circuits

From Fig. 4:04 it can be seen that M-101 acts as a variable sensitivity ammeter in series with the cell when measuring cell current, and a voltmeter when placed in the CELL position.

Full scale indication in the CELL position represents a voltage of 20 v across the cell. Cell voltage in excess of 20 v will cause the meter to read off scale.

> Note: V-101 does not glow at the low cell voltages which occur above 1000 ppm.

CR-101 protects M-101 against excessive current by allowing no more than about 750 millivolts to develop across the meter before it conducts.

R-109 and R-111 form the recorder output circuit. R-111 allows the output to be adjusted from 0-100 mv when the meter reads full scale.

4.2 SAMPLE FLOW SYSTEM

As shown in Fig. 1:01, the gas to be sampled flows through the filter, electrolytic cell, and variable flow regulator, and out the outlet fitting.

4.2.1 Sample Parts

The sample inlet and outlet parts are standard 1/8-inch Swagelok bulkhead fittings. Part numbers are shown on Fig. 4:03.

4.2.2 Sample Filter

A 10-micron stainless steel filter is an integral part of the "sample in" cell case nozzle as shown in Fig. 4:05. If replacement of the filter is required, the whole nozzle assembly must be replaced.

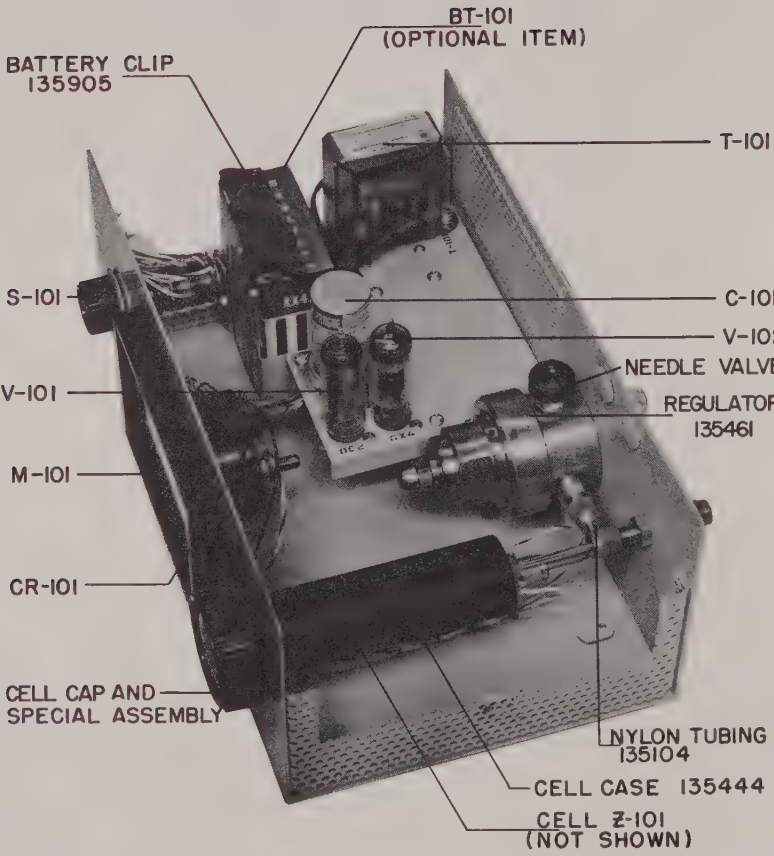
4.2.3 Electrolytic Cell and Case

The electrolytic cell is a readily accessible, self-contained module. It is composed of a small diameter tube which contains two platinum electrodes. The tube is bent into a "U", and potted into a solid plastic cylinder for permanence. Both ends of the electrode tube terminate at ports drilled in a Teflon plug which caps the cell. These ports mate interchangeably with

the two gas-sample nozzles at the bottom of the cell case. Two spring contacts, mounted on the cell, provide electrical connection for the d-c voltage which causes electrolysis of water within the cell. Assembly of the cell and case are shown in Fig. 4:05.

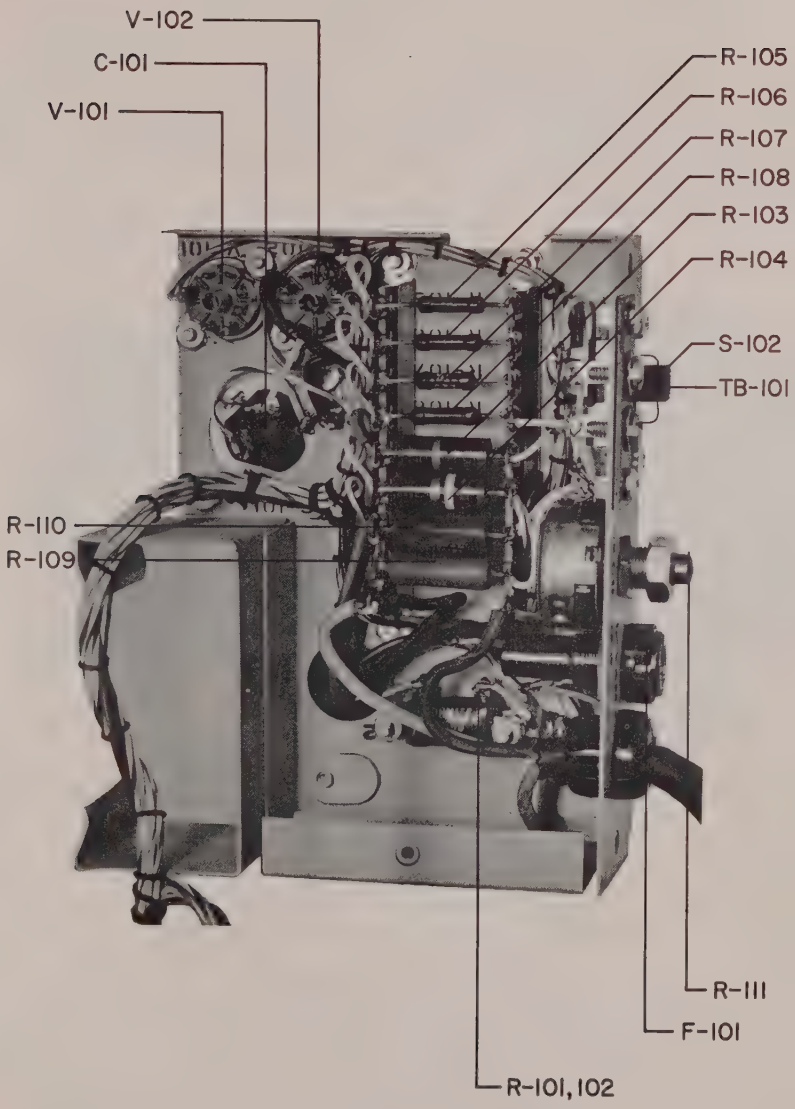
4.2.4 Variable Flow Regulator

Sample flow through the instrument is controlled by the variable flow regulator. Variations of sample inlet pressure from 20 to 100 psi are regulated to a constant 10 psi. This constant output pressure is dropped across the built-in needle valve. Thus, by the needle valve adjustment, the desired sample flow may be obtained and it will be regulated regardless of inlet pressure changes.

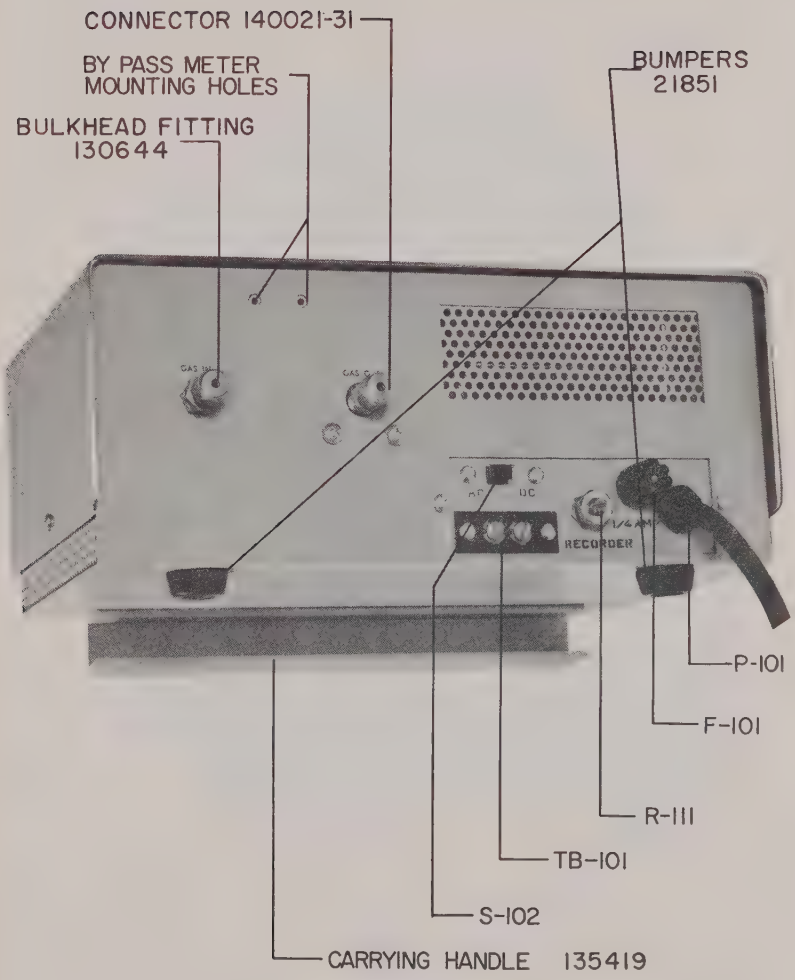


TOP INSIDE CHASSIS

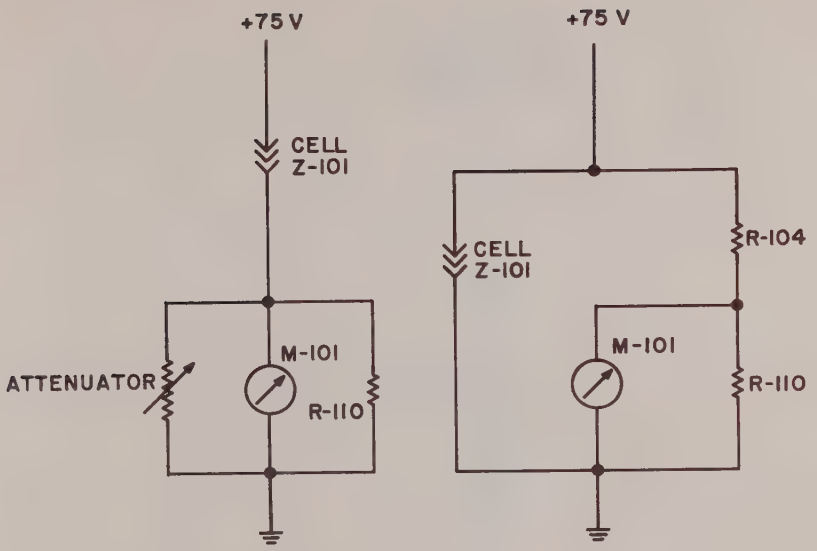
FIG. 4:01



ELECTRONIC CHASSIS
FIG. 4:02



REAR VIEW
FIG. 4:03

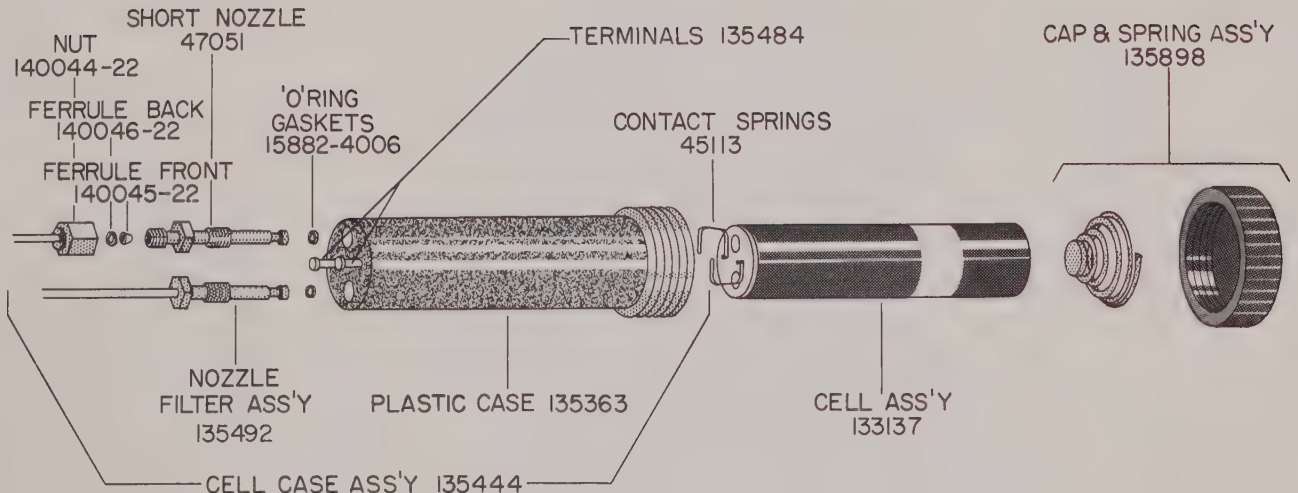


A. MEASUREMENT OF CELL CURRENT

B. MEASUREMENT OF CELL VOLTAGE

SIMPLIFIED DIAGRAMS

FIG. 4:04



CELL AND CELL CASE ASS'Y
FIG. 4:05

26-303
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PART 5

MAINTENANCE

5.1 SAMPLE FLOW ADJUSTMENT AND CALIBRATION

To maintain accuracy of readings, the sample flow should be checked periodically and readjusted if necessary. Normal operating conditions creating the need for flow adjustment are discussed in Part 3.

For most accurate measurement of flow the Bubble-O-Meter (CEC #134072) is recommended. A properly calibrated floating ball flowmeter may be used, keeping in mind that the calibration of such a device depends on the gas being used and is invalid if the device is not clean.

Follow instructions provided with whichever device is being used, taking care that the connection to the instrument sample out port is free of gas leaks.

5.2 SAMPLE FLOW REGULATOR

The flow regulator is supplied by CEC as a complete unit. If replacement parts are required, they must be obtained from the manufacturer, Millaflow (see Fig. 5:01).

5.2.1 Adjustment

All internal adjustments are fixed, and care should be exercised to return all parts to the regulator in their proper relationships following cleaning procedures. Adjustment of flow through the unit is accomplished with the needle valve shown in Figs. 4:01 and 5:01.

5.2.2 Cleaning

Fig. 5:01 shows disassembly of the regulator for cleaning purposes. Frequency of cleaning and solvents used depend on the contaminating material. The regulator diaphragm is neoprene and will be attacked by solvents such as aromatic hydrocarbons.

Disassemble the unit and carefully remove any solid foreign matter.

Carefully clean all parts using appropriate solvents. Do not file or scrape parts, since this could result in permanent malfunction.

Wash thoroughly with clean acetone and blow completely dry with dry nitrogen or dry, clean air.

Reassemble immediately to prevent condensation of ambient moisture and keep in a dry place.

5.2.3 Operational Test

Install regulator in instrument and, using a dry gas, set sample flow to 100 cc/min by means of the needle valve.

Vary inlet pressure and check flow to see that it remains within ±2% over the inlet pressure range of 20-100 psig.

5.3 SAMPLE FILTER

The sample filter, as mentioned before, is an integral part of the inlet line nozzle. It may sometimes be cleaned but, if clogged with particulate matter, usually must be discarded.

5.3.1 Cleaning

Remove nozzle from cell case. Again, the solvent to be used is determined by the contaminating material.

Back flush (opposite normal flow) with solvent until clean.

Flush with clean acetone to remove first solvent and force dry nitrogen through the filter until all traces of acetone are removed before replacing in cell case.

5.4 BATTERY

A discussion of use and testing of the battery is contained in Part 3.2.2. Life of the battery is limited to about one year when not in use, and proportionally shorter depending on use. Purchase a fresh battery only as needed, as they should not be stored for extended periods.

5.5 ELECTROLYTIC CELL RECOATING

The need to recoat the cell can arise if the coating is accidentally washed out by introduction of liquid or becomes covered with oil or dirt. This condition is usually detected by a low reading on a known gas.

Also, accidental introduction of particulate matter may cause an electrical short circuit which thorough cleaning of the cell will remove. Shorts or partial shorts are indicated by a less than 2-volt or noisy cell voltage reading. Another evidence is when the cell will not "dry down" on a known dry gas.

5.5.1 Cleaning

a. Using a glass hypodermic syringe without a needle as shown in Fig. 5:02, flush cell with distilled water. Use care to avoid damage to the ends of the cell elements. Do not force the end of the syringe against the bottom end of the port.

b. Flush cell with acetone, alcohol, carbon tetrachloride, or other solvents as required to remove oil and dirt.

c. Flush with distilled water followed by acetone.

d. Blow out any liquid droplets with air.

e. Test cell before coating by reinstalling in the instrument. With normal flow of a dry gas the uncoated cell should give a reading of less than 1 ppm in a few minutes' time.

f. If a short circuit remains after the above cleaning procedure, an electric spark will sometimes burn away foreign matter.

Connect one cell terminal to an electrical ground such as a water pipe, and apply a high voltage, low current spark coil (Tesla) to the other terminal. A visible spark inside the cell port indicates that the short probably was removed.

CAUTION

Do not use 115 v from power mains.

g. If the short circuit cannot be removed by sparking, carefully fill the cell with concentrated nitric acid and allow to stand for 1/2 hour.

h. Flush several times with distilled water and follow with acetone, drying and testing as before.

5.5.2 Recoating

CAUTION

Read entire procedure before attempting any part of it.

a. Before recoating, the cell should always have been flushed with acetone and dried with dry nitrogen.

b. Using the same hypodermic syringe as before, fill the cell with the coating solution and withdraw excess. Coating solution may be mixed by combining concentrated, chemically pure phosphoric acid (85% H_3PO_4 in water) and acetone, in the proportion of 8 parts acetone to 2 parts phosphoric acid by volume.

CAUTION

It is extremely important that both the phosphoric acid and the acetone by chemically pure, reagent grade materials.

c. After withdrawing the excess fluid, subject the cell to an inert gas flow to dry it out before voltage is applied. It is important that the gross quantity of acetone be carried off before electrolysis is initiated. This is necessary to prevent the excess heat generated within the cell from decomposing the acetone during the electrical dry-out. If no gas is available to initially dry the cell, as an alternate it can be placed in a vacuum desiccator for a few hours.

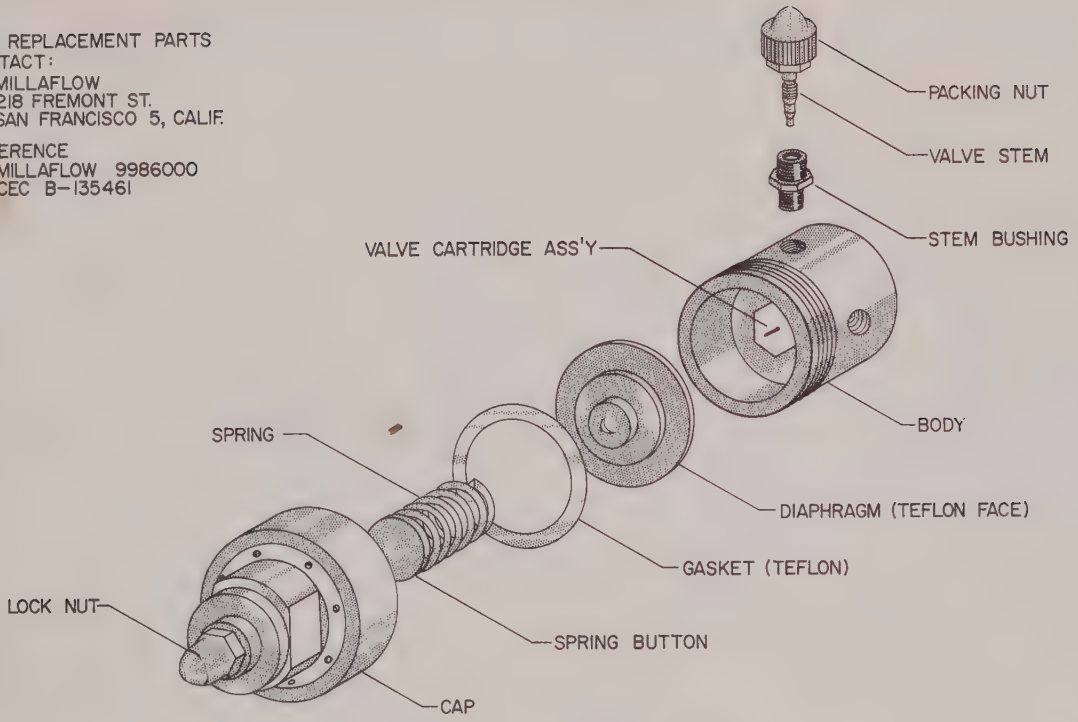
In order that the proper equilibrium be established within the cell coating, a freshly coated cell should be operated for a few hours before the readings can be considered representative.

While the procedure as outlined above is not particularly complicated, it should be carried out only under laboratory conditions. As in any laboratory

procedure, cleanliness is extremely important. Solvents, if used, should be reagent grade material. They must be completely free of suspended particulate matter. The syringe used and especially the "O" ring which is fitted to it should be inspected periodically to insure the absence of any contamination or foreign material. After any rinse procedure, the cell must be completely dry before any resistance measurement is made. In no case should the cleaning and recoating of a cell be undertaken by personnel who have not read this manual and familiarized themselves with the procedure.

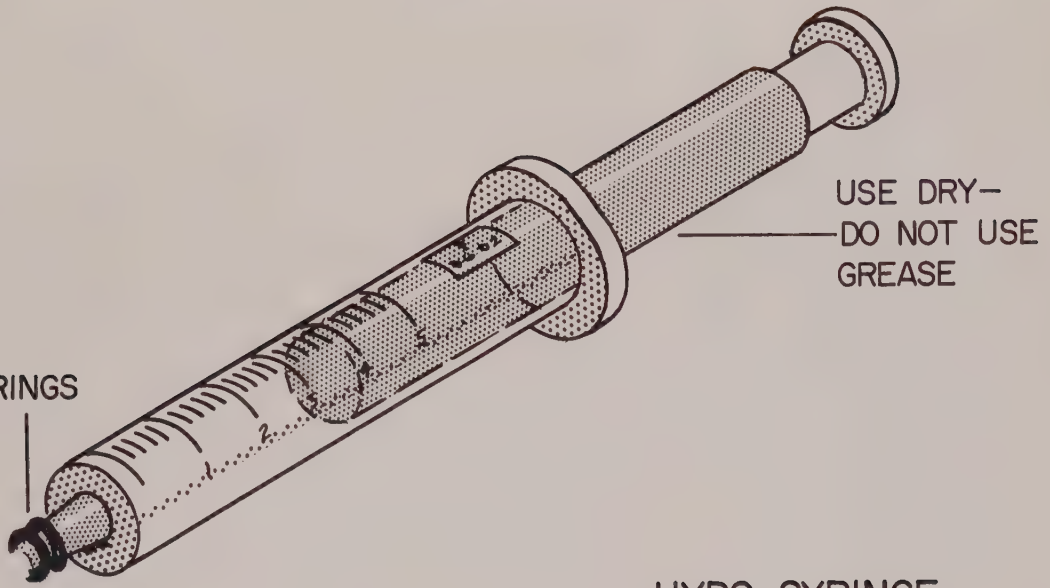
FOR REPLACEMENT PARTS
CONTACT:
MILLAFLOW
218 FREMONT ST.
SAN FRANCISCO 5, CALIF.

REFERENCE
MILLAFLOW 9986000
CEC B-135461



SAMPLE FLOW REGULATOR
FIG. 5:01

26-303
2185 9-61



HYPO SYRINGE
FIG. 5:02

26-303
2185 9-61

PART 6

TROUBLESHOOTING

Successful troubleshooting of the instrument depends on a thorough working knowledge of the entire system. It is important to know the details of construction of the instrument and its theory of operation but a good understanding of capabilities and limitations is also required. What at first observation appears to be instrument malfunction is often in reality an abnormal condition in the sample streams, power system, etc.

The instructions given on the following pages are intended to be a guide to a few of the more common troubles encountered.

Symptom	Possible Cause	Test Point	Repair
6.1 Meter reads zero on all attenuator positions	No a-c power	----	Unit plugged in? S-102 in A. C. position?
	No a-c power	Pins 1 and 6, V-102 (250 v a-c)	Check F-101 and T-101
	No d-c power	Pins 5 (+) and 2 of V-101 (75 v d-c)	Check V-102, R-101, R-102, and C-101
	M-101 open or shorted	Disconnect meter terminals (2640 Ω)	Check for deflection and continuity with ohmmeter. Caution: Do not use X1 attenuation as excessive current from ohmmeter may damage M-101.
	CR-101 shorted	Across diode	Check front and back resistance
	Broken wire	Almost anywhere	Check point to point continuity
6.2 Meter reads zero on all attenuator positions except CELL	Cell not making contact	Cell terminals (remove cell)	Inspect for bent contacts

Symptom	Possible Cause	Test Point	Repair
6.2 Meter reads zero on all attenuator positions except CELL (continued)	Cell open	Cell terminals (remove cell)	Replace cell
	Open wire	S-101 circuits	Check point to point
6.3 Meter reads off scale on all attenuator positions	Cell partially shorted	----	Replace or recoat
	System flooded with H_2O	----	Disconnect instrument from sample stream and dry with dry gas.
6.4 Meter reads off scale on all attenuator positions except CELL	Instrument drying	Cell voltage above 2 v and rising	Allow to operate until dry.
	Cell shorted	Cell voltage below 2 v or steady	Replace or recoat cell.
6.5 "Noisy" meter reading	Sample flow variation	Check sample flow	Clean or replace filters Clean regulator
	Cell shorting	----	Replace or recoat
	Power supply noisy	Pin 5 (+) and 7 of V-101 (no large variations)	Check V-102, R-101, R-102, C-101, T-101

Symptom	Possible Cause	Test Point	Repair
6.6 Meter reading known to be incorrect	Gas flow rate incorrect	Check sample flow	Reset flow adjustment; clean or replace filters
	Attenuator resistor damaged	R-105 through R-108	Replace defective resistor
	Meter damaged	Meter resistance 2640 Ω at 100 μa	Repair or replace meter
	Cell partially shorted or partially inactive	Check instrument on wet and dry streams	Recoat or replace cell

PART 7

ACCESSORIES

7.1 SAMPLE AND BYPASS METER - Catalog No. 26-011

Used to reduce response time or for rapid purge of moisture from sample lines, the unit allows for measurement of both the sample flow and the bypass flow.

Table 7:01 lists, by dash number, the various ranges of sample flowmeters available. All sample flows are given for 70°F and 14.7 psia. The by-pass meters indicate from 90-900 cc/min for the same temperature and pressure. The flow diagram for the unit is shown in Fig. 7:01.

TABLE 7:01

Catalog No.	To be Used with Moisture Monitor No.	Sample Flow Rate in cc/min	Calibrated for
26-011-3	26-303 & 26-303MB (All Dash Nos.)	25-250	Air
26-011-3MA	26-303ME-10 & 26-303ME-30	25-250	Air
26-011-4	26-303MA (All Dash Nos.)	3-30	Air
26-011-4MA	26-303ME-20	3-30	Air

The unit is mounted in the holes shown in Fig. 4:03 and sample line connections are made with the standard 1/8-inch Swagelok fittings provided.

Flow correction factors for several gases other than air are given in the table, Appendix C.

7.2 BUBBLE-O-METER - Part No. 134072

The instrument, shown in Fig. 7:02, is recommended for measurement and adjustment of sample flow. It may also be used for calibration

of mechanical type flow indicators. Operating instructions are provided with the instrument.

7.3 SAMPLE FILTER

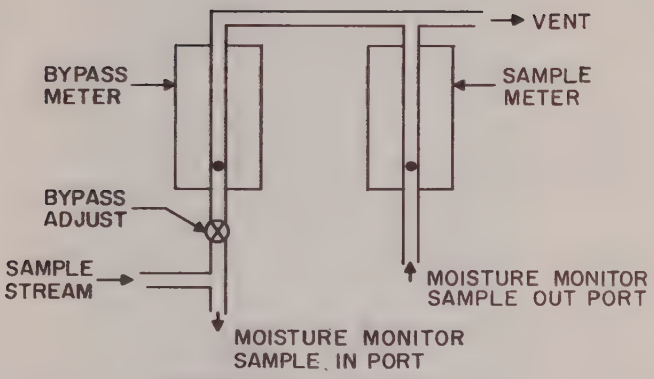
Use of a sample filter is recommended for all but the cleanest applications. The unit available from CEC is nickel plated brass, has a replaceable stainless steel filter element and is available in a number of porosities. Selection of porosity is variable according to conditions, but a final filtering action of 2 micron size is required for reliable operation. See Fig. 7:03 for assembly and parts identification. The filter proper terminates in 1/8-inch tubing on one end, and will accept the same size tubing on the other.

7.4 OIL SEPARATOR - Part No. 131513

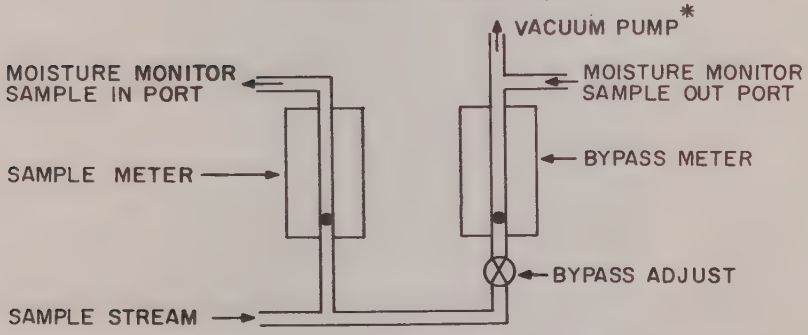
The oil separator is used to remove oil mist and droplets from a sample stream with little sacrifice in system response. Construction is of Teflon and stainless steel, and a valve is provided for periodic draining of accumulated oil. Assembly and parts are shown in Fig. 7:04.

7.5 ADJUSTABLE ALARM - CATALOG NO. 26-033

Will operate an alarm over the entire range of the 26-303 Moisture Monitor. Also, it could be used as an adjustable alarm on any device giving a d-c millivolt output in a range of 20 millivolts.



PRESSURE OPERATION



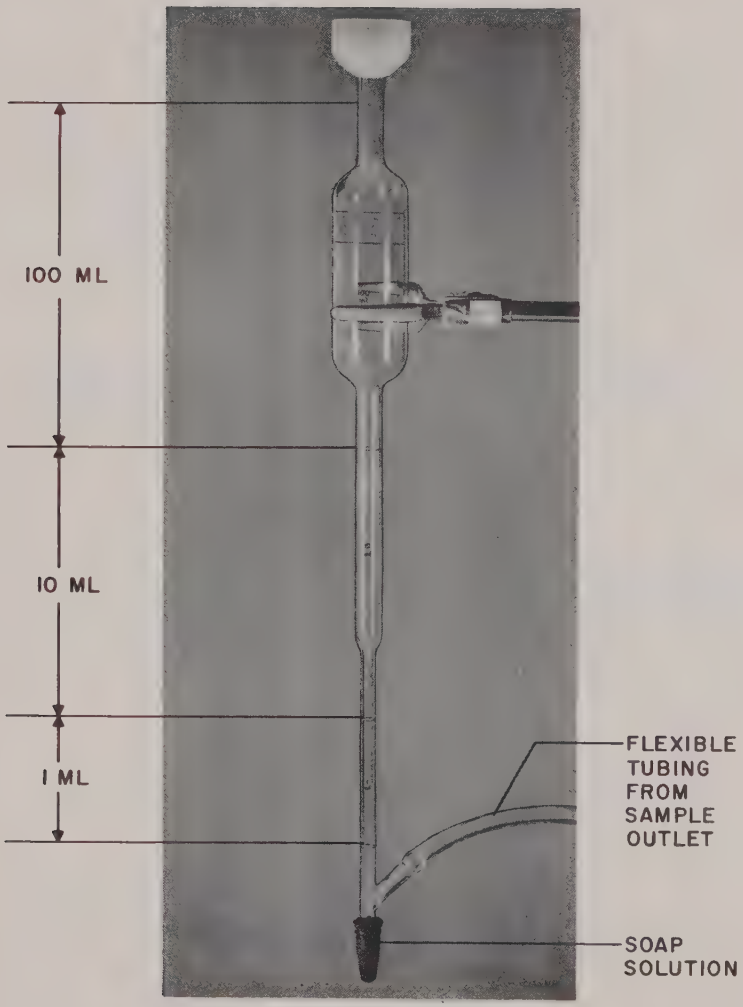
* A ONE OR TWO LITER BALLAST VOLUME IN PUMP LINE WILL HELP SMOOTH OUT PUMP FLUCTUATIONS.

VACUUM OPERATION

FLOW DIAGRAMS

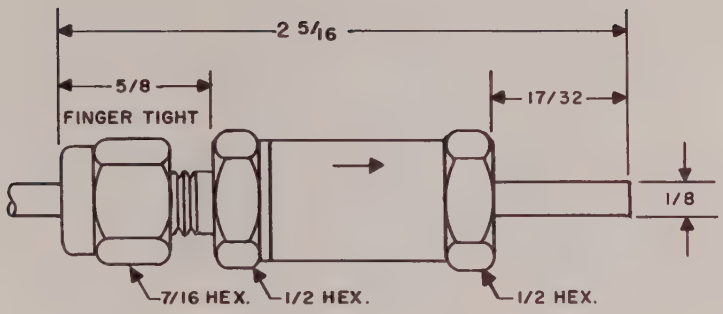
FIG. 7:01

26-303
2185 4-63



#134072 BUBBLE-O-METER

FIG. 7:02



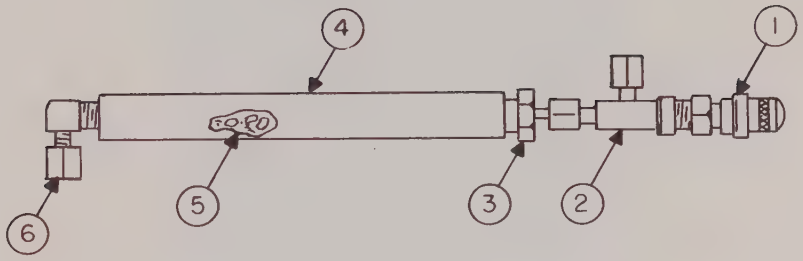
FILTER COMPLETE	
FILTER SIZE (MICRONS)	C.E.C. PART NO.
1	137878-1
2	137878-2
5	137878-3
7	137878-4

FILTER ELEMENTS ONLY	
FILTER SIZE (MICRONS)	C.E.C. PART NO.
1	137878-17
2	137878-18
5	137878-19
7	137878-20

137878 SAMPLE FILTERS

FIG. 7:03

26-303
2185 7-62



ITEM	DESCRIPTION	PART NO.
1	PURGE VALVE	131513 — 13
2	TEE, T.F.T.	130470
3	ADAPTER	131513 — 12
4	TUBE, S.ST.	131513 — 14
5	TEFLON SHAVINGS	130652
6	MALE ELBOW	131513 — 11

OIL SEPARATOR

FIG. 7:04

PART 8

STANDARD MODIFICATIONS

Certain minor modifications to the instrument are available from the factory as "standard" modifications. These generally consist of a change of range, readout, mode of operation, or mounting. Identification of a modified instrument may be made by inspecting the type number. The Type Number 26-303 will be followed by two letters and a dash number, such as 26-303MA-1. Where M indicates "modified", A indicates the type of modification, and -1 identifies the specific modification.

Following is a listing of all standard modifications and detailed information for all changes made to the original instrument. This information is intended to be supplementary to that supplied in the preceding sections.

8.1 26-303MA HIGH RANGE MOISTURE MONITOR

Sample streams containing up to 10,000 ppm moisture can be analyzed by the 26-303MA. The high dynamic range is the basic difference between this modification and the standard 26-303 and is effected by limiting the sample flow rate through the cell to 10 cc/min. The attenuator allows selection of either of five full scale ranges 0-100, 0-300, 0-1000, 0-3000, and 0-10,000 ppm. Four meter scales are available for readout in either ppm, lbs per million cu ft, mgs per liter, or ppm with alternate dew point.

8.1.1 Variations from Standard Instrument

8.1.1.1 Component

Resistor R-110: See Table 8:01
Resistor R-112*: See Table 8:01
Meter Scale: See Table 8:01

8.1.1.2 Operating Techniques

The only difference in operation of the Type 26-303MA from the procedures outlined for the standard instrument is that the 26-303MA requires a flowrate of 10 cc/min of sample gas through the cell.

After the instrument has attained the ultimate ambient operating conditions for each sample that is to be monitored, the flowrate should be adjusted to 10 cc/min by turning the needle valve on the flow controller (see Fig. 4:01). Because the flow rate is low and a slight error would greatly affect accuracy of the readings, a rotameter device and/or preferably a Bubble-O-Meter should be used to measure the gas leaving the "SAMPLE OUT" port.

A bypass line connected close to the instrument "SAMPLE IN" port is recommended to give more rapid response to a change in moisture content (see Part 2.1), and to equilibrate the instrument when it is first installed. If a bypass system is not used for the 26-303MA, the response time is probably too great even if the sample lines are short. Before operating this instrument, the manual should be read, particularly the sections on sampling techniques (Part 2). Also, if a particular instrument has a PPM with Alternate Dew Point Meter Scale, the section on the Type 26-303MC (see Part 8.3) should be read.

*Resistor R-112, when used, is placed in series with M-101.

Dash No.	Dynamic Range	Meter Scale Part No.	R-110	Part No. R-110	R-112	Part No. R-112
-1	0-10,000 parts per million	B-135729	Standard		Standard	
-2	0-500 lbs. per million cu ft	B-135730	10K, 1/2 w ±1%	70047-385	137 Ω, 1/2 w ±1%	70047-206
-3	0-10 mgs per liter	B-135731	5.76K, 1/2 w ±1%	70047-362	845 Ω, 1/2 w ±1%	70047-282
-4	ppm with dew point	per customer spec	Standard		Standard	

Table 8:01

26-303MA

8.2 26-303MB LOW RANGE MOISTURE MONITOR

The Type 26-303MB Moisture Monitor is essentially the same as the Type 26-303, except that it has been modified to have a higher sensitivity. The dynamic range is 0-100 ppm, and there are five full scale ranges 0-1, 0-3, 0-10, 0-30, 0-100 ppm depending on the attenuator multiplier position. The higher sensitivity is achieved by increasing the sample flow rate to 200 cc/min and changing the meter. Four separate meter scales are available allowing readout in ppm, lbs per million cubic ft, milligrams per liter, and ppm with dew point.

8.2.1 Variation from Standard Instrument

8.2.1.1 Components

Meter (M-101): Part No. C-135733
Resistor R-112*: See Table 8:02
Resistor R-104: Changed from 150K to 750K ohms so that full scale reading is still 20 v d-c with the attenuator at the "cell" position.
Meter Scales: See Table 8:02
Recorder Output: 0-20 mv, adjustable

8.2.1.2 Operating Techniques

The only difference in operation of the Type 26-303MB from the procedures outlined for the standard instrument is that the 26-303MB requires a flow rate of 200 cc/min of sample gas through the cell. The needle valve on the flow controller (see Fig. 4:01) is used to control the flow rate which can be measured with a Bubble-O-Meter or rotameter device. For most accurate results, the flow rate should be adjusted to 200 cc/min after the instrument has attained the ultimate ambient operating conditions for each sample that is to be monitored.

The importance of eliminating "tramp" moisture cannot be over-emphasized when monitoring samples with extremely low moisture content (less than 1.0 ppm). It is not unusual for a 0.5 ppm sample to read 1.0 ppm or more, the difference being "tramp" moisture. Consequently, it is very important to make sure that the sample lines are as dry as or drier than the sample itself. Heating the lines with sample flowing (moisture monitor disconnected) minimizes or even eliminates this problem.

*Resistor R-112 when used, is placed in series with M-101.

Another aid to true readings is the use of suitable material for the sample lines. Suggested materials in decreasing order of desirability are: (1/8" tubing preferred - maximum 1/4").

1. Teflon (if wall thickness is heavy enough to assure no pinholes in the walls).
2. Stainless steel.
3. Copper or brass.

Under no conditions should Tygon, rubber, or any other material that is permeable to water be used for the sample system.

If short sample lines cannot be used conveniently, it is suggested that the bypass be used to give more rapid response to a change in moisture content (see Part 2.1).

Before operating this instrument the manual should be read, particularly the sections on sampling techniques (Part 2). Also, if a particular instrument has a PPM with Alternate Dew Point Meter Scale, the section on the Type 26-303MC (see Part 8.3) should be read.

Dash No.	Dynamic Range	Meter Scale Part No.	R-112	R-112 Part No.
-1	0-100 parts per million	Standard for 135733 meter	None	----
-2	0-5 lb per million cu ft	B-135734	137 Ω, 1/2 w ±1%	70047-206
-3	0-0.1 mgs per liter	B-135735	845 Ω, 1/2 w ±1%	70047-282
-4	ppm with dew point	Per customer spec	None	----

Table 8:02

26-303MB

8.3 26-303MC MOISTURE MONITOR WITH CHANGED METER SCALE

This modification changes the standard unit only in the respect that three different meter scales may be utilized to read out lb per million cu ft, mgs per liter, or ppm with alternate dew point.

8.3.1 Variations from Standard Instrument

8.3.1.1 Components

Meter Scale: See Table 8:03
Resistor R-110: See Table 8:03
Resistor R-112*: See Table 8:03

8.3.1.2 Operating Techniques

The Type 26-303MC requires nearly the same operating techniques as the standard Type 26-303. The only variation is incurred with the PPM with Alternate Dew Point Meter Scale. Because dew point versus moisture content is not linear, the application to dew point is limited to one attenuator setting only; this is governed by the particular specifications to be met. For example, if specifications require moisture monitoring from dew points of -70°F to -5°F, which is from 17 ppm to 960 ppm respectively, the attenuator would have to be set at X100 to utilize the full scale.

Before operating this instrument, the manual should be read, particularly the sections on sampling techniques (Part 2).

*Resistor R-112, when used, is placed in series with M-101.

Dash No.	Dynamic Range	Meter Scale Part No.	R-112	R-112 Part No.
-1	0-50 lbs per million cu ft	B-135737	137, 1/2 w ±1%	70047-206
-2	0-1 mgs per liter	B-135738	845 Ω, 1/2 w ±1%	70047-282
-3	ppm with dew point	Per customer spec	Standard	

Table 8:03

26-303MC

8.5 26-303ME ATMOSPHERIC SAMPLING MOISTURE MONITOR

This modification is a 26-303 Moisture Monitor with a vacuum pump internally mounted and plumbed to draw sample gas through the instrument from pressures close to atmospheric pressure. The pump is connected to the "SAMPLE OUT" port.

Twelve separate versions are available as listed in Table 8:04. These include the dynamic ranges and scales identical to the 26-303, 26-303MA (High Range), 26-303MB (Low Range), and 26-303MC.

8.5.1 Variations from Standard Instrument

8.5.1.1 Drawings

Schematic C-136648 gives the basic wiring for the Type 26-303ME (both the Moisture Monitor and the vacuum pump); overall dimensions, etc., are given in the installation drawing D-136630.

8.5.1.2 Components

The 26-303ME-3X modifications do not have a sample filter installed in the "Gas In" fitting. An external filter is provided (CEC Part #137878-2).

8.5.1.3 Operating Techniques

Before turning the instrument on, the manual should be read, particularly the sections on sampling techniques (Part 2). If a particular instrument has a high dynamic range (0-10000 ppm) a low dynamic range (0-100 ppm) and/or a PPM with Alternate Dew Point, the sections on the Type 26-303MA (see Part 8.1) Type 26-303MB (see Part 8.2), and/or Type 26-303MC (see Part 8.3), respectively, should be read.

Do not turn the pump on until the meter indicates less than 30 ppm, and the instrument is connected to the dry sample line. When the pump is first turned on, the meter will probably go off scale, but should return within a very few minutes if the sample and lines are dry.

If the pump is turned off for any reason, allow at least one minute for the pressure to reach close to atmospheric pressure. If this is not done, the pump may not operate when turned on again.

8.6 26-303MG RACK MOUNTED ATMOSPHERIC SAMPLING MOISTURE MONITOR

This model consists of the following modifications to a Type 26-303:

1. The Moisture Monitor is mounted in a standard RETMA #SE102, Size E panel (for 19-inch relay rack).

2. All variations of scale and range of the Type 26-303 are available. Table 8:04 lists the variations by dash number.

3. A vacuum gage and sample and bypass flowmeters are plumbed to the Moisture Monitor and mounted in the relay rack.

4. A vacuum pump (NOT included) that should be equivalent to or better than the Neptune Dynapump #3 is available at most chemical supply houses (CEC #136428). The pump may be mounted by CEC at additional cost if desired.

8.6.1 Variations from Standard Instrument

8.6.1.1 Drawings

The overall dimensions, etc., are given in the installation drawing D-136978.

8.6.1.2 Components

Standard RETMA #SE102, Size E Panel.

26-011-XMA Sample and Bypass Flowmeters.

Vacuum gage - 0-30 in Hg vacuum, CEC #136959.

The 26-303MG-3X modifications do not have a sample filter installed in the "Gas In" fitting. An external filter is provided (CEC Part #137878-2).

Resistors, meter scales, meter and recorder output are dependent upon specifications for dynamic range and meter scale graduations

8.6.1.3 Operating Techniques

Before turning the instrument on, the manual should be read, particularly the sections on sampling techniques (see Part 2). If a particular

instrument has a high dynamic range (0-10,000 ppm), a low dynamic range (0-100 ppm) and/or a PPM with Alternate Dew Point Meter Scale, the sections on the Type 26-303MA (see Part 8.1), Type 26-303MB (see Part 8.2), and/or Type 26-303MC (see Part 8.3), respectively, should be read. The section on the Type 26-303ME (see Part 8.5) should be thoroughly examined for atmospheric sampling techniques. Also, to prevent saturating or flooding the cell, the vacuum pump should be on ONLY when the instrument is operating.

8 7 26-303MH RACK MOUNTED PRESSURE SAMPLING MOISTURE MONITOR

This model consists of the following modifications to a Type 26-303:

1. The Moisture Monitor is mounted in a standard RETMA #SE102, Size E Panel (for 19-inch relay rack)

2. All variations of scale and range of the Type 26-303 are available. Table 8:04 lists the variations by dash number.

3. Sample and bypass flow meters are plumbed to the Moisture Monitor and mounted in the relay rack.

8.7.1 Variations from Standard Instrument

8.7.1.1 Drawings

The overall dimensions, etc., are given in the installation drawing D-136992.

8.7.1.2 Components

Standard RETMA #SE102, Size E Panel

26-011-X Sample and Bypass Flowmeters

Resistors, meter scales, meter, and recorder output are dependent upon specifications for dynamic range and meter scale graduations.

8.7.1.3 Operating Techniques

Before turning the instrument on, the manual should be read, particularly the sections on sampling techniques (see Part 2). If a particular instrument has a high dynamic range (0-10000 ppm), a low dynamic range (0-100 ppm), and/or a PPM with Alternate Dew Point Meter Scale, the sections on the Type 26-303MA (see Part 8.1), Type 26-303MB (see Part 8.2), and/or Type 26-303MC (see Part 8.3), respectively, should be read.

TABLE 8:04

SCALE AND RANGE VARIATIONS

Standard Range Variations

26-303XX-10:	Same as standard 26-303
26-303XX-11:	Same as 26-303MC-1
26-303XX-12:	Same as 26-303MC-2
26-303XX-13:	Same as 26-303MC-3

High Range Variations

26-303XX-20:	Same as 26-303MA-1
26-303XX-21:	Same as 26-303MA-2
26-303XX-22:	Same as 26-303MA-3
26-303XX-23:	Same as 26-303MA-4

Low Range Variations

26-303XX-30:	Same as 26-303MB-1
26-303XX-31:	Same as 26-303MB-2
26-303XX-32:	Same as 26-303MB-3
26-303XX-33:	Same as 26-303MB-4

PART 9

RECOMMENDED SPARE PARTS AND SUPPLIES

A complete list is not given since all components may be identified on the schematic (C-135350) and other figures. The parts listed below will normally require replacement or repair over an extended period of time.

Quantity	Description	Part No.
1	Cell, electrolytic	133137
1	Diode, Type 1N1692 (GE)	131538-1
1	Electronic Tube, 6X4	70091-60
1	Electronic Tube, 0C2	70091-205
5	Fuses, 1/4 amp, quick acting	140080-9
4	"O" Rings (nozzle assembly)	15882-4006
1	Nozzle Assembly	135492
1	Nut, 1/8" brass	140044-21
1	Nut, 1/8" stainless steel	140044-22
4	Ferrules, front, 1/8", brass	140045-21
4	Ferrules, front, 1/8" stainless steel	140045-22
4	Ferrules, back, 1/8" brass	140046-21
4	Ferrules, back, 1/8" stainless steel	140046-22
1	Pipe Sealant, Loctite	17484-97

ADDITIONAL SPARE PARTS FOR ME MODIFICATIONS

1	Vacuum Pump	136428
5	Fuses, 1 1/2 amp, slo-blo	140080-31
2	Illuminators, Type NE-2H, 117 v a-c	134490-4
2	Filter Elements, 2 microns	137878-18

APPENDIX A

THE ELECTROLYTIC CELL

The physical construction of a CEC electrolytic cell is shown in Fig. A-1. The sample enters the cell through one of the ports in the Teflon end piece and passes through the length of glass tubing inside the cell, exiting at the other port. Affixed to the inside of the glass tubing are two parallel, helically wound platinum wires. Between these wires, which are the electrodes, a thin layer of phosphorous pentoxide is deposited on the glass. The wires are brought out through leak-tight seals to the electrical contacts in the Teflon end piece.

The assembly described above is potted in epoxy resin for mechanical protection and this normally prevents damage from any cause except the entrance of objects through the cell ports. For this reason, NEVER insert any object such as a probe, syringe needle, wire, etc., into the small hole at the bottom of the port which leads into the cell. Such action invariably results in abrupt, permanent termination of the cell's usefulness.

When inserted in an instrument connected to an appropriate sample stream, the cell functions in the following way to provide a conversion of sample water content into an electrical signal:

> The instrument's flow controller provides that sample flow, as measured at the outlet, shall remain essentially constant over the specified range of input pressure. The electrolytic cell thereby receives sample gas at a fixed rate, and so receives moisture at a rate which varies only as the moisture content of the sample gas varies.

The moisture in the gas is detected in a very specific manner by the electrolytic cell, and most other gaseous materials do not interfere. The cell determines the moisture entering it by absorbing this gaseous water on the thin film of phosphorous pentoxide deposited between the two electrodes. The voltage applied to these electrodes from the power supply causes them to be highly polarized, and electrolysis of the absorbed water into molecular hydrogen and oxygen results. Since phosphorous pentoxide is extremely hygroscopic and the cell geometry is such as to cause intimate contact of the gas with the absorbing film, all of the water vapor entering is absorbed and electrolyzed. This accounts for the high degree of accuracy and specificity possible with a moisture

monitor, since the process is virtually unique for water and consumes at least 99.9% of the gaseous water at levels as low as 1.0 ppm or as high as 20,000 ppm.

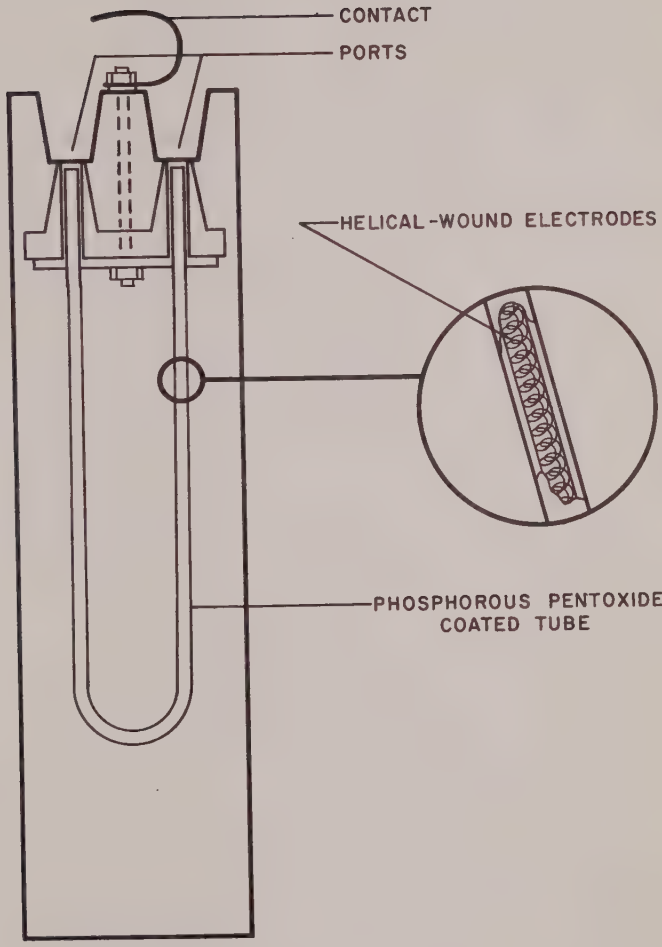
The chemical and electrochemical reactions occurring are the following, expressed as simply as possible:

$$H_2O\,(g) + P_2O_5 \xrightarrow{(1)} P_2O_5 \cdot H_2O \xrightarrow{(2)} P_2O_5 + H_2\,(g) + 1/2\,O_2\,(g)$$

Step one is a simple chemical absorption of gaseous water by phosphorous pentoxide, which renders the film electrically conductive. Step two is electrolysis of the water into its component elements of hydrogen and oxygen, accompanied by a transfer of charge from one cell electrode to the other. If water is entering at a given rate, as in an equilibrium state, it will be absorbed and electrolyzed at a constant rate, resulting in a steady rate of charge transfer, which is synonymous with a constant current. Thus, current is directly and linearly related to mass flow-rate of water, and the magnitude of the resultant current may be calculated from Faraday's Law, the flow-rate of gas, and the relationship between mass flow-rate and volume flow-rate.

When these factors are considered for water being electrolyzed by a moisture cell, it becomes evident that the current in microamperes per ppm of water is given by I = (0.132 x flow rate) μa where the flow rate is the sample flow rate in cc/min, measured at 1.00 atm pressure and 25°C. Thus, for example, at 20 cc/min, 1 ppm water produces 2.64 μa; at 100 cc/min, 13.2 μa.

Phosphorous pentoxide in its dry state is a very poor conductor of electricity, so the background signal not due to water is extremely low. The lowest readings ever obtained with a moisture monitor correspond to just less than 0.1 ppm, and indicate an internal d-c cell resistance of more than 50 megohms. The error due to leakage in the cell, therefore, must be at least this small, and is probably smaller.



ELECTROLYTIC CELL —— SIMPLIFIED DRAWING

26-303
2185 9-61

FIG. A-1

APPENDIX B

HYDROGEN AND OXYGEN STREAMS

GENERAL

When using the moisture monitor to measure moisture content in hydrogen or oxygen, or in mixtures having a high percentage of hydrogen, an exaggerated reading will be produced. This is due to the inherent tendency of the free oxygen or hydrogen from the electrolysis of water to recombine with the gas in the sample stream. The re-formed water is re-electrolyzed to produce the higher reading. Errors due to 0_2 are much less than errors due to H_2. In practice, errors in readings on air or 0_2 streams are generally insignificant if the true moisture level exceeds 20 ppm.

It has been found that for sample flow rates in the range used, the reformation of water is constant. This effect allows a simple technique to be used for determination of true moisture level in the presence of the high background reading.

In practice, if the sample flow rate is doubled, the reading due to moisture will be doubled, but the reading due to interfering gas will remain the same.

CAUTION

A new determination must be made each time either the sample stream composition or the true moisture level changes.

PROCEDURE

Adjust sample flow rate to exactly 100 cc/min and read the indicated moisture level.

Readjust flow rate to exactly 200 cc/min and again read the indicated moisture level.

Subtract the reading obtained at 100 cc/min from the reading at 200 cc/min; the result is the true moisture level.

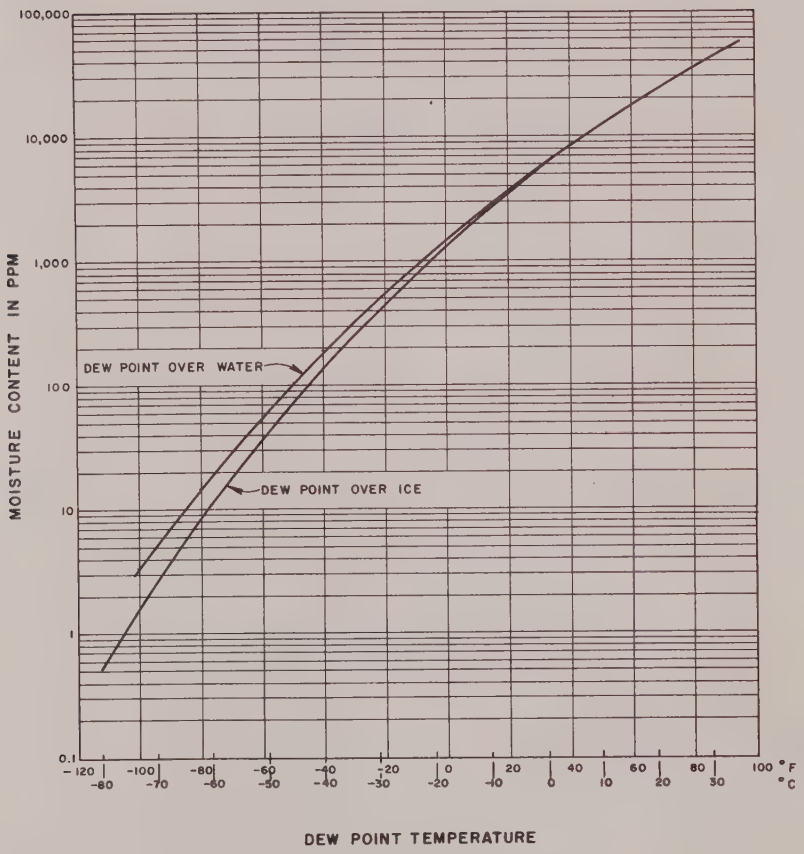
APPENDIX C

FLOW CORRECTION FACTORS FOR GASES OTHER THAN AIR USED WITH THE CEC 26-011 SAMPLE BY-PASS

Gas	Actual Flow Factor (Air = 1.00)	Density lbs/cu ft at 70° 14.7 psia	Spec. Volume cu ft/lb at 70° 14.7 psia
Acetylene	1.041	0.068	14.70
Air	1.000	0.075	13.34
Argon	0.848	0.103	9.68
Butane (n)	0.695	0.1565	6.39
Carbon Dioxide	0.806	0.1145	8.74
Carbon Monoxide	1.020	0.0725	13.8
Chlorine	0.622	0.1865	5.36
Ethane	0.970	0.0785	12.73
Ethylene	1.020	0.0725	13.8
Helium	2.693	0.0103	96.7
Hydrochloric Acid	0.873	0.0950	10.51
Hydrogen	3.796	0.0052	192.5
Methane	1.346	0.0415	24.10
Methyl Chloride	0.758	0.1304	7.67
Nitric Oxide	0.978	0.0775	12.90
Nitrogen	1.020	0.0725	13.80
Nitrous Oxide	0.832	0.1140	8.77
Oxygen	0.952	0.0827	12.10
Propane	0.800	0.1170	8.55
Sulfur Dioxide	0.656	0.1700	5.88
Bromine	0.426		
Chloroform Vapors	1.847		
Hydrobromic Acid	0.605		

APPENDIX D

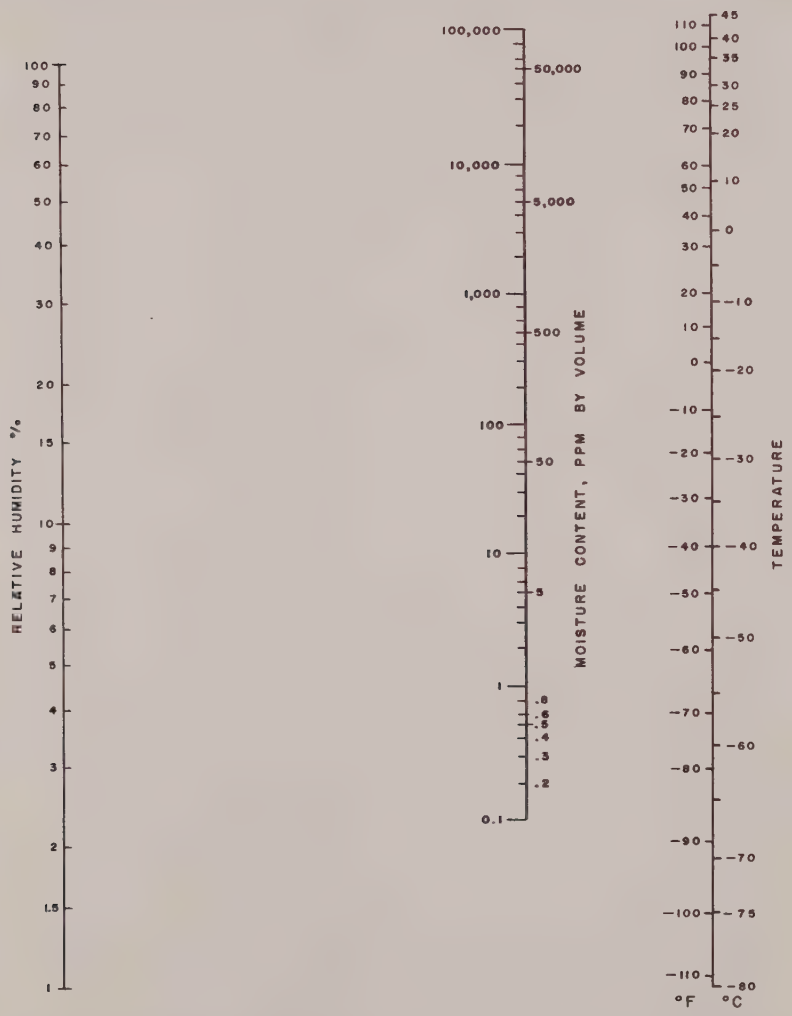
CONVERSION FROM PPM H_2O TO DEW POINT



The graph relates absolute moisture levels, as obtained on the moisture monitor, to dew point in either °F or °C.

APPENDIX E

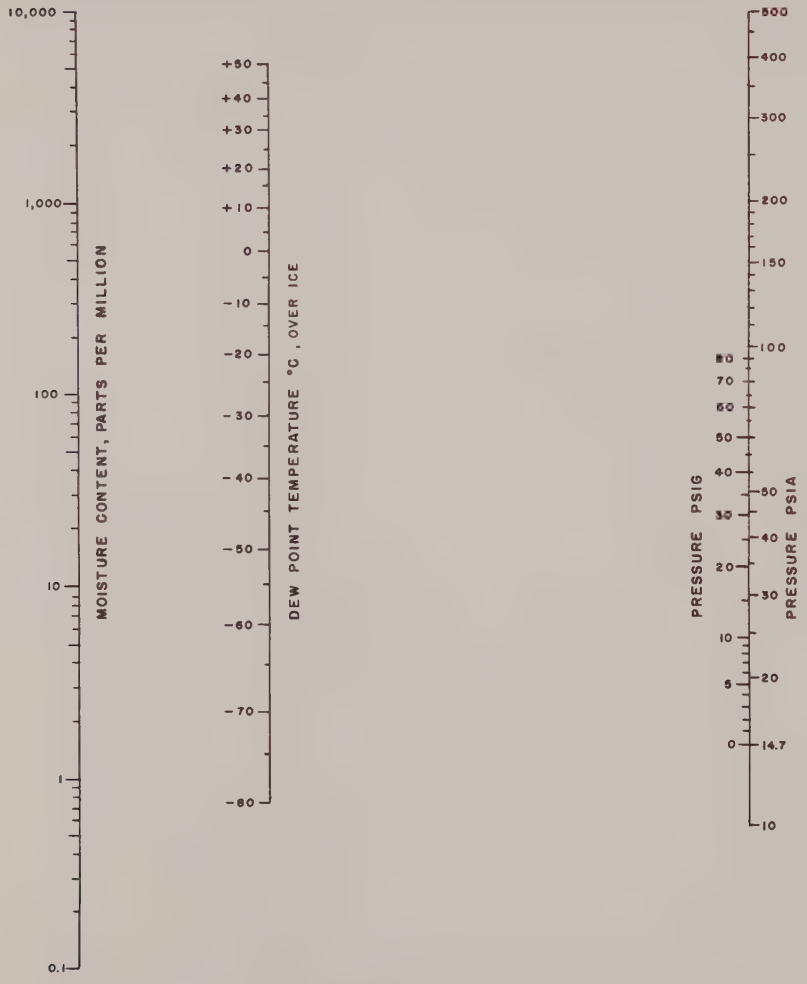
CONVERSION OF PPM H_2O TO RELATIVE HUMIDITY



With a known moisture content in ppm at a given temperature, place a straight edge across these values on the proper scale. Read the value of relative humidity where the extended straight edge crosses.

APPENDIX F

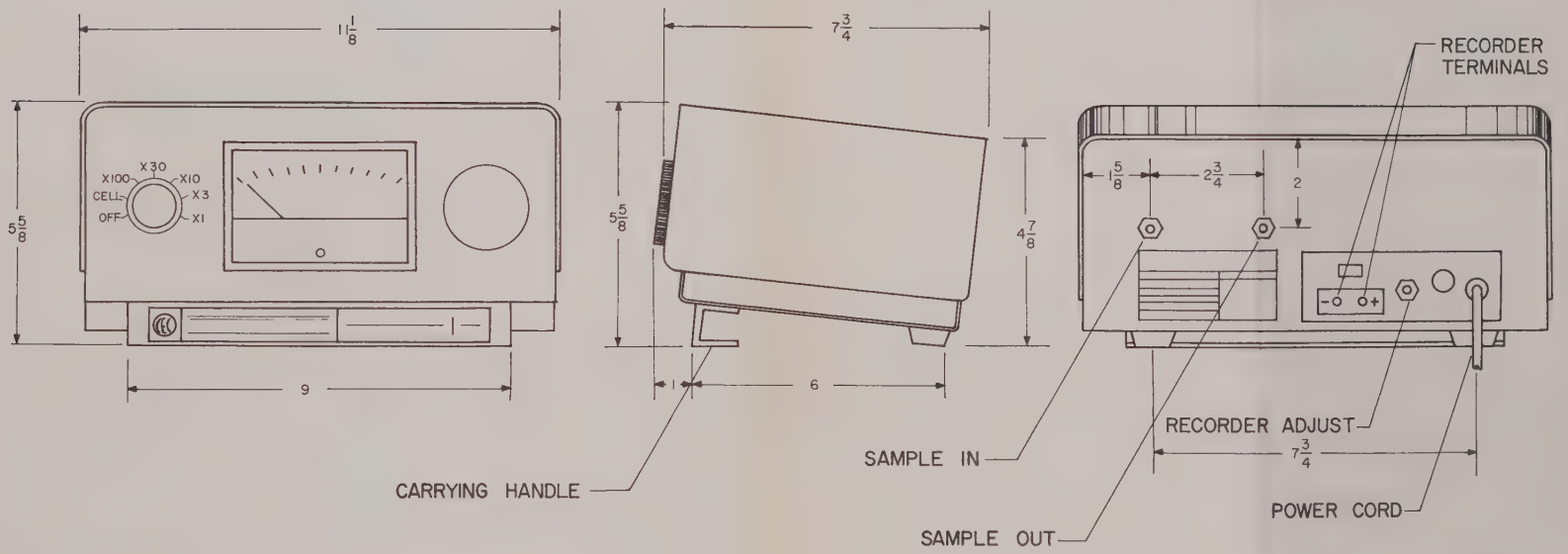
DETERMINATION OF DEW POINT VARIATION WITH PRESSURE



Align a straight edge on the known moisture content (in ppm) and pressure points. Read dew point where the straight edge crosses.

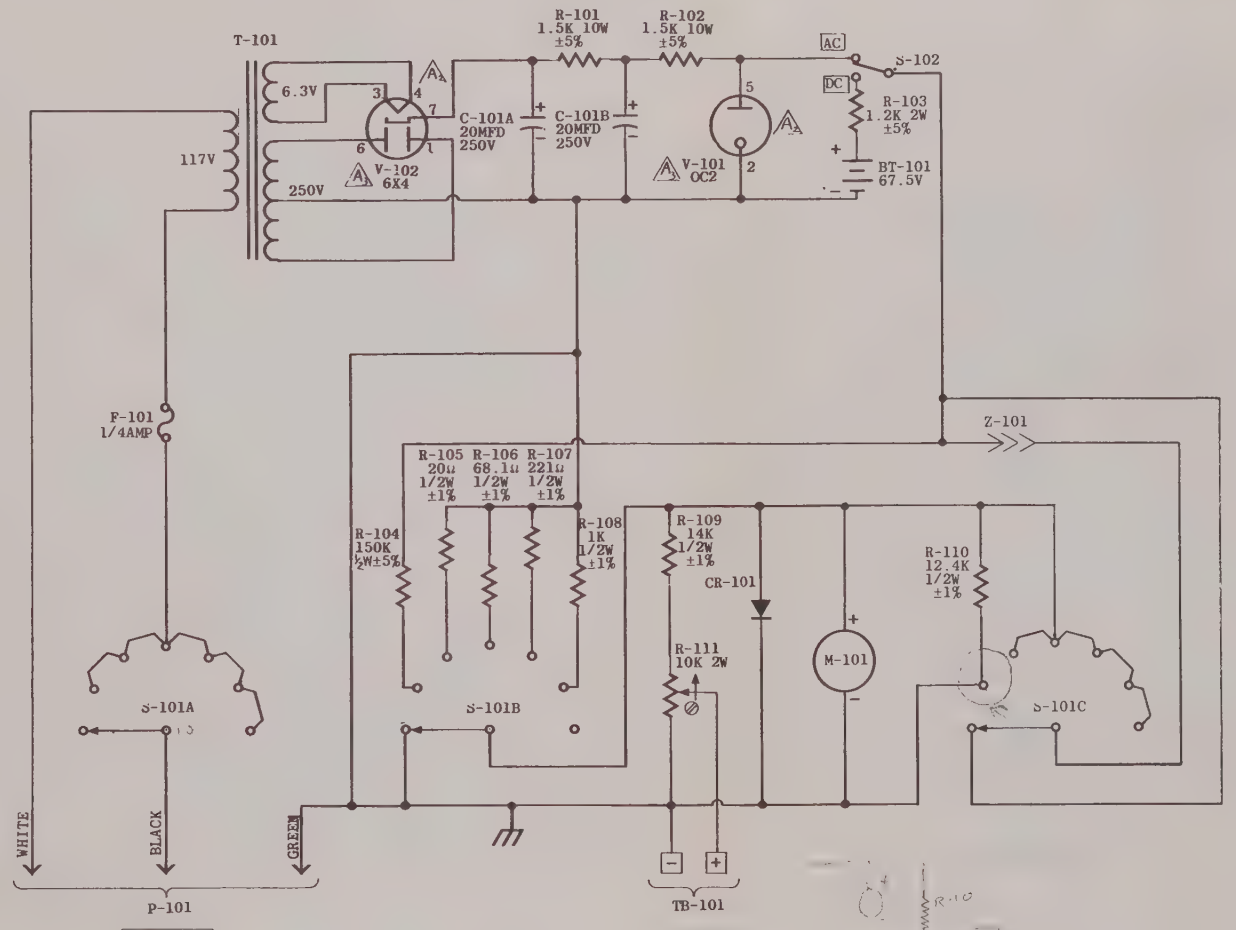
NOTES

1. REQUIRES 115 V AC, 50/60 ~ SINGLE PHASE, OR INTERNAL BATTERY.
2. POWER CONSUMPTION = 10 WATTS MAX.
3. WEIGHT = 15 LBS.
4. SAMPLE FITTINGS ARE $\frac{1}{8}$ SWAGELOK BRASS COMPRESSION FITTINGS.
5. RECORDER OUTPUT ADJUSTABLE 0–110 MV.
6. POWER CORD 8 FT. LONG WITH 3 PRONG PLUG.

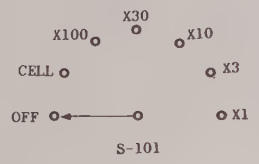


INSTALLATION DWG.
C-136014 | C-135300 (REF)

C-135350 CHG A



	SYMBOL	PART NO.
1 2	BT-101	REF.
	C-101	A-135413
1	CR-101	B-131538-1
2	F-101	140080-9
1	M-101	C-135388
2	P-101	B-39310-6
	R-101	A-135460
	R-102	A-135460
	R-103	7140-1225
	R-104	7138-1545
	R-105	70047-126
	R-106	70047-177
	R-107	70047-226
	R-108	70047-289
	R-109	70047-399
	R-110	70047-394
2	R-111	A-38729
1	S-101	A-39607-54
2	S-102	A-135462
2	T-101	B-135414
2	TB-101	A-135084
A 1	V-102	70091-60
	V-101	70091-205
1	Z-101	B-13315[illegible]



5. ALL COMPONENTS MARKED ⟨⟩ ARE LISTED FOR REFERENCE ONLY AND MAY BE FOUND ON THE FOLLOWING ASS'YS. AS INDEXED.
   - ⟨1⟩ MOISTURE MONITOR ASS'Y C-135300
   - ⟨2⟩ ELECTRONIC CHASSIS ASS'Y C-135412
4. WIRE PER RUNNING WIRE LIST A-135433.
3. ALL ROTARY SWITCHES SHOWN IN MAXIMUM COUNTER-CLOCKWISE POSITION AS VIEWED FROM FRONT PANEL.
2. SYMBOL ⊘ ON POTENTIOMETERS INDICATES SCREWDRIVER ADJUSTMENT.
1. ARROWS ON POTENTIOMETERS INDICATE CLOCKWISE ROTATION FROM SHAFT END.

NOTES:

ZONE	CHG		DATE	BY	CHKD	APPD
B-2	B	1) R-104 WAS 7140-1545	11-8 61	W. Gray		
B-2	A	3) INTERCHANGED SYM. V-101 & V-102	7-861	C.P.		
B-2		2) ADDED PIN NOS. TO V-101 & V-102				
A-1		1) INTERCHANGED SYM. V-101 & V-102				

TYPE	NEXT ASS'Y
C6-303	C-135300

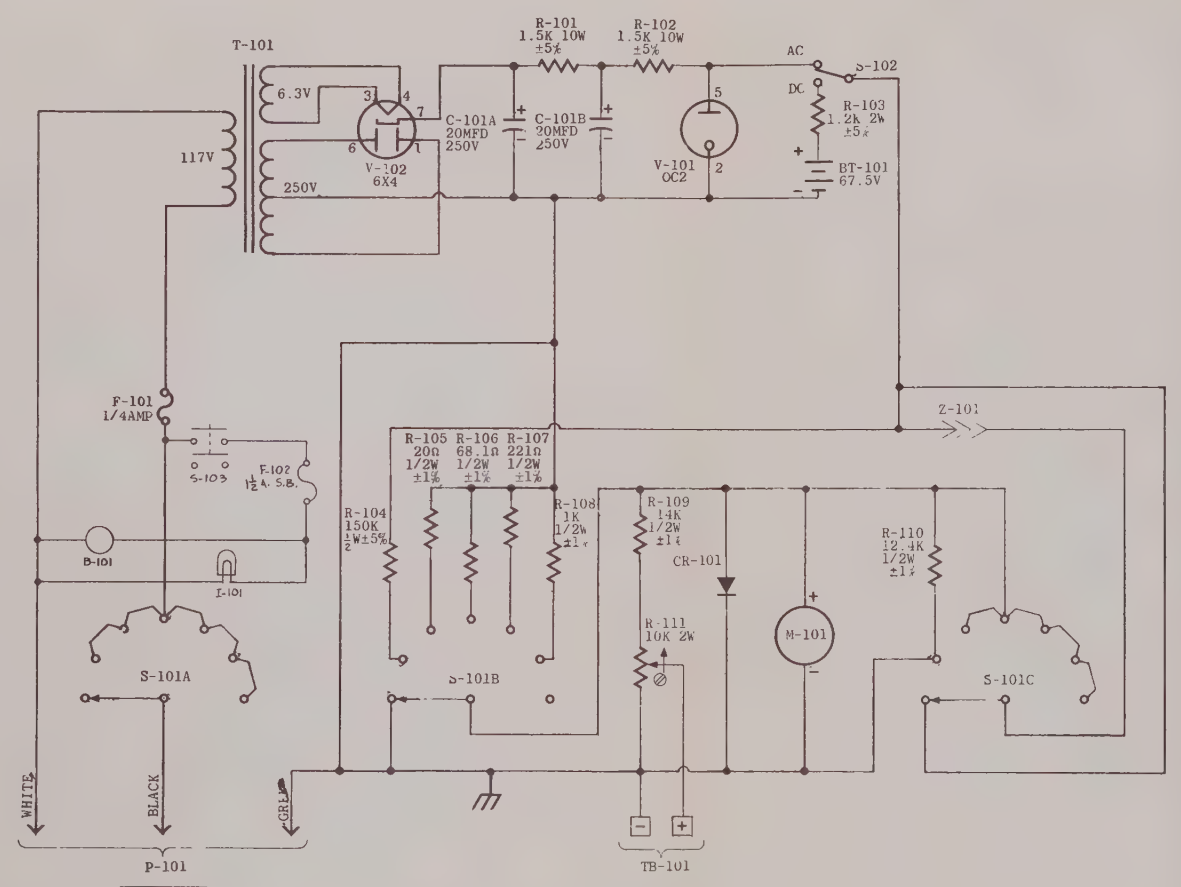
ANALYTICAL & CONTROL INSTRUMENTS DIVISION
CONSOLIDATED ELECTRODYNAMICS CORPORATION
PASADENA CALIFORNIA

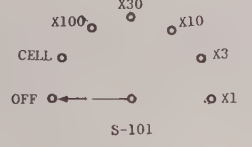
LIMITS ON DIMS & SPECIFICATIONS UNLESS OTHERWISE NOTED
ANGULAR FRACTIONAL DECIMAL
1 BREAK ALL SHARP CORNERS .015 MAX
2 SURFACE ROUGHNESS 63 MICROINCH R.M.S. MAX
3 DIAMETERS TO BE CONCENTRIC WITHIN .005 T.I.R.
4 FILLET RADIUS .010 MAX. 5 THREADS CLASS 3
DO NOT SCALE DRAWING SCALE
MATL APPD
FINISH APPD
DRAWN BY W.G. Gray 6-7-61
CHKD BY
CHKD BY R.P.L. 2-3-61
PROD. DSGN
PROJ. ENG. R. Marsh 6-23-61

SCHEMATIC MOISTURE MONITOR C-135350 CHG 8

CEC 208 (REV. 3)

3 6-23 61





NOTES:

5. ALL COMPONENTS MARKED ⬡ ARE LISTED FOR REFERENCE ONLY AND MAY BE FOUND ON THE FOLLOWING ASS'YS. AS INDEXED.
   - (1) MOISTURE MONITOR ASS'Y C-135300
   - (2) ELECTRONIC CHASSIS ASS'Y C-135412
4. WIRE PER RUNNING WIRE LIST A-135433.
3. ALL ROTARY SWITCHES SHOWN IN MAXIMUM COUNTER-CLOCKWISE POSITION AS VIEWED FROM FRONT PANEL.
2. SYMBOL ⊘ ON POTENTIOMETERS INDICATES SCREWDRIVER ADJUSTMENT.
1. ARROWS ON POTENTIOMETERS INDICATE CLOCKWISE ROTATION FROM SHAFT END.

ZONE	CHG	DESCRIPTION	DATE	BY	CHKD	APPD
	A	F-102 WAS 1A. 140080-30	11/6/62	E.K.	J.S.	M.C.

TYPE	NEXT ASS'Y
26-303 ME-13	D-135970
26-303 ME-10	D-135970
26-303 ME-23	D-135970
26-303 ME-20	D-135970

SYMBOL	PART NO.
BT-101	REF.
C-101	A-135413
CR-101	B-131538-1
F-101	140080-9
M-101	C-135388
P-101	B-39310-6
R-101	A-135460
R-102	A-135460
R-103	7140-1225
R-104	7138-1545
R-105	70047-126
R-106	70047-177
R-107	70047-226
R-108	70047-289
R-109	70047-399
R-110	70047-394
R-111	A-38729
S-101	A-39607-54
S-102	A-135462
T-101	B-135414
TB-101	A-135084
V-102	70091-60
V-101	70091-205
Z-101	B-133137
B-101	A-136428
F-102	140080-31
I-101	A-134490-4
S-103	A-131697

ANALYTICAL & CONTROL INSTRUMENTS DIVISION

CONSOLIDATED ELECTRODYNAMICS CORPORATION

PASADENA CALIFORNIA

LIMITS ON DIMS & SPECIFICATIONS UNLESS OTHERWISE NOTED

ANGULAR
FRACTIONAL
DECIMAL

1. BREAK ALL SHARP CORNERS .015 MAX
2. SURFACE ROUGHNESS 63 MICROINCH R M S MAX
3. DIAMETERS TO BE CONCENTRIC WITHIN .005 T I R
4. FILLET RADIUS .010 MAX B. THREADS-CLASS 2

DO NOT SCALE DRAWING

SCALE

DRAWN BY PS 12-15-61

CHKD BY

CHKD. BY

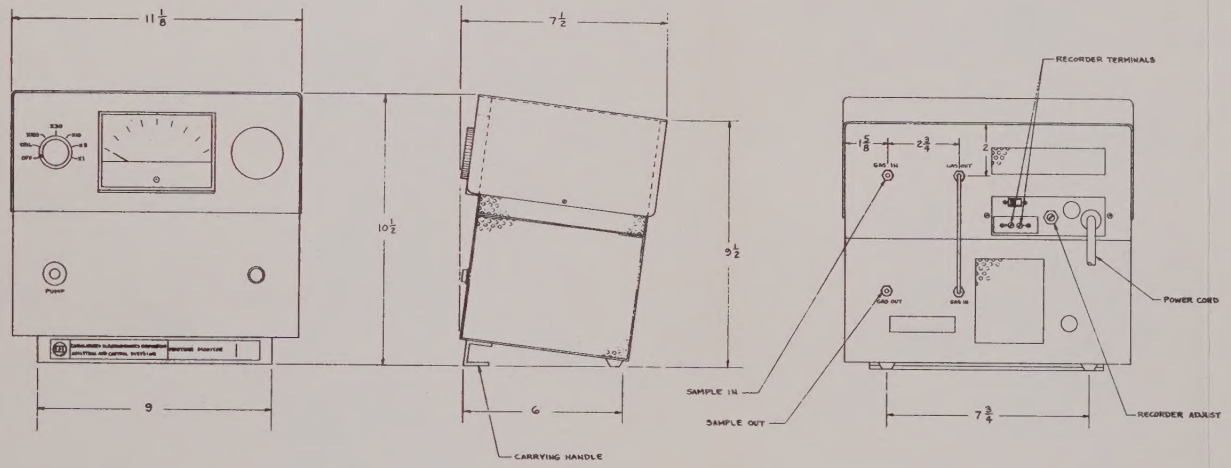
PROD. DSGN'L M. LAUGHLIN 12/4/61

PROJ. ENG. R. Mandl

SCHEMATIC MOISTURE MONITOR

C-136648 CHG A

D-136630 REV A



6. POWER CORD 8 FT. LONG WITH 3 PRONG PLUG.
5. RECORDER OUPUT ADJUSTABLE
4. SAMPLE FITTINGS ARE 1/8 SWAGELOK BRASS COMPRESSION FITTINGS.
3. WEIGHT = 20 LBS..
2. POWER CONSUMPTION =150 WATTS MAXIMUM.
1. REQUIRES 115 V. A.C., 50/60 ~ SINGLE PHASE

NOTES:

ANALYTICAL & CONTROL INSTRUMENTS DIVISION

CONSOLIDATED ELECTRODYNAMICS CORPORATION
PASADENA CALIFORNIA

ZONE	CHG	DESCRIPTION	DATE	BY	CHKD	APPD
	A	NOTE "2 WAS 60 WATTS				

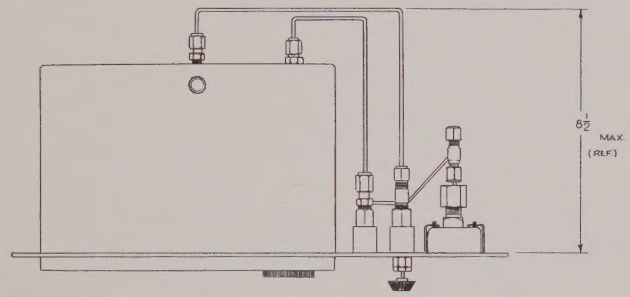
TYPE	NEXT USE Y
26-303ME	D-135970

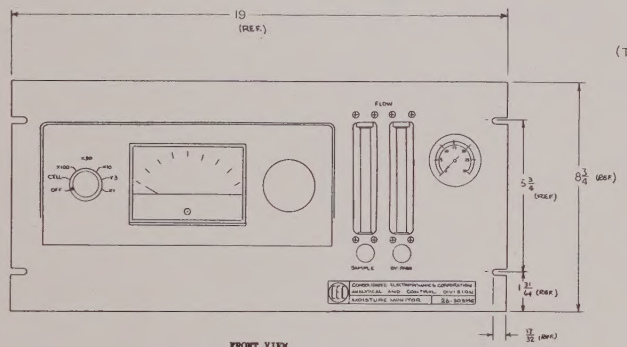
LIMITS ON DIMS. & SPECIFICATIONS UNLESS OTHERWISE NOTED
ANGULAR
FRACTIONAL
DECIMAL
DO NOT SCALE DRAWING
MATL
FINISH
1. BREAK ALL SHARP CORNERS .010 MAX.
2. SURFACE ROUGHNESS 63 MICRONCH R.M.S. MAX.
3. DIMENSIONS TO BE CONCENTRIC WITHIN .005 T.I.R.
4. FILLET RADIUS .010 MAX. & THREAD-CLASS 2
SCALE
DRAWN BY REISINGER 7/1/61
CHKD. BY
ENGR'G APPR.
PROD. SERVICE APPR.

INSTALLATION DWG.—
MOISTURE MONITOR, TYPE 26-303ME

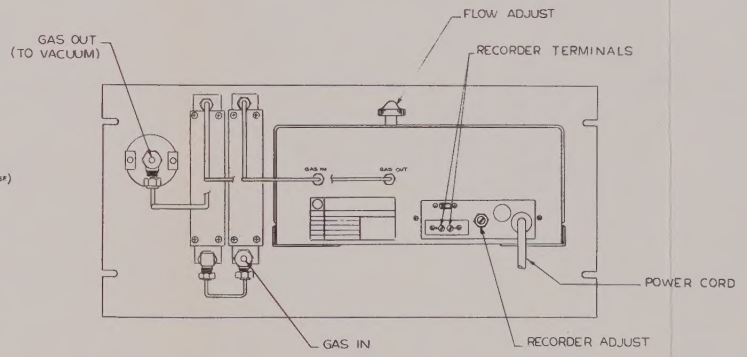
D-136630 | CODE A

D-136978-A





FRONT VIEW



REAR VIEW

6. POWER CORD 8 FT. LONG WITH 3 PRONG PLUG.
5. RECORDER OUTPUT ADJUSTABLE.
4. SAMPLE FITTINGS ARE 1/8 SWAGELOK BRASS & ST. STEEL COMPRESSION FITTINGS.
3. WEIGHT: 20 lbs.
2. POWER CONSUMPTION: 30 WATTS MAXIMUM.
1. REQUIRES 115 V.A.C., 50/60 CYCLES SINGLE PHASE

NOTES:

ZONE	CHG	DESCRIPTION	DATE	BY	CHKD	APPD	TYPE	NEXT ASSY
B-8	A	ADDED FLOW ADJUST	6-6-62	RK	WS	6/6	26-303MG	D-135972

ANALYTICAL & CONTROL INSTRUMENTS DIVISION

CONSOLIDATED ELECTRODYNAMICS CORPORATION
PASADENA CALIFORNIA

LIMITS ON SIZES & SPECIFICATIONS UNLESS OTHERWISE NOTED
ANGULAR
FRACTIONAL
DECIMAL
DO NOT SCALE DRAWING
SCALE
MATL
FINISH
1. BREAK ALL SHARP CORNERS .015 MAX.
2. SURFACE ROUGHNESS AS MICROINCH A.S.A. MAX.
3. DIMENSIONS TO BE CONCENTRIC WITHIN .005 T.I.R.
4. FILLET RADIUS .010 MAX. 5. THREADS—CLASS 2

DRAWN BY R. KENT 2-2-62
CHKD. BY G.J. 2-6-62
COMP. BY
APPD.
PROD. ENGR. APPD.
PROJ. ENG. APPD.

INSTALLATION DRAWING
MOISTURE MONITOR 26-303MG-

D-136978 A